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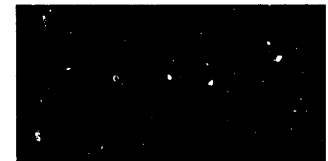
1 OF 1

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4 May 1979

TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY
PHYSICAL SCIENCES AND TECHNOLOGY
(FOUO 25/79)



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TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY PHYSICAL SCIENCES AND TECHNOLOGY

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CONTENTS

PAGE

GEOPHYSICS, ASTRONOMY AND SPACE

Astronomical Theory of Oscillations in Earth's Climate
(I.L. Vilius, A.S. Monin; IZVESTIYA AKADEMII NAUK SSSR,
FIZIKA ATMOSFERI I OKEANA, No 1, 1979) 1

French Metallurgy Experiments Aboard 'Salyut-6'
(AIR ET COSMOS, 31 Mar 79) 19

PHYSICS

Improving The Efficiency of the Utilization of Uranium in the
RBMK-1000
(I. Ya. Yemel'yanov, et al.; ATOMNAYA ENERGIYA, Mar 79) .. 20

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

History of Moscow Geological Exploration Institute
(D.P. Lobanov; IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY:
GEOLOGIYA I RAZVEDKA, No 3, 1979) 26

History of the Geophysics Department at MGRI
(D.S. Dayev, L.L. Lyakhov; IZVESTIYA VYSSHIKH UCHEBNYKH
ZAVEDENIY: GEOLOGIYA I RAZVEDKA, No 3, 1979) 55

Scientific and Technical Information Dissemination in Scien-
tific-Research Institutes
(S.M. Matveyev; NAUCHNO-TEKHNICHESKAYA INFORMATSIIYA,
SERIYA 1, ORGANIZATSIYA I METODIKA INFORMATSIONNOY
RABOTY, Feb 79) 64

Managing Translators, Patent Workers and Export-Service
Personnel
(V.P. Tkach; NAUCHNO-TEKHNICHESKAYA INFORMATSIIYA,
SERIYA 1, ORGANIZATSIYA I METODIKA INFORMATSIONNOY
RABOTY, Feb 79) 67

- a - [III - USSR - 23 S & T FOUO]

FOR OFFICIAL USE ONLY

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CONTENTS (Continued)	Page
Moisey Davydovich Gandlevskiy (1904-1979) Obituary (NAUCHNO-TEKHNICHESKAYA INFORMATSIYA, SERIYA 1, ORGANIZAT- SIYA I METODIKA INFORMATSIONNOY RABOTY, Feb 79)	70
PUBLICATIONS	
Geometrical Theory of Diffraction (Vladimir Andreyevich Borovikov, Boris Yevseyevich Kinber, GEOMETRICHESKAYA TEORIYA DIFRAKTSII, 1978)	71
New Book on Experimental Methods, Results With Power Reactors (I. N. Aborina; FIZICHESKIYE ISSLEDOVANIYA REAKTOROV VVER, 1978)	73
Crystal Growing From Solutions and Melts (Valentina Aleksandrovna Timofeyeva; ROST KRISTALLOV IZ RASTVOROV-RASPLAVOV, 1978)	76

- b -

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GEOPHYSICS, ASTRONOMY AND SPACE

UDC 551.581:551.583.3

ASTRONOMICAL THEORY OF OSCILLATIONS IN EARTH'S CLIMATE

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ATMOSFERY I OKEANA in Russian,
Vol 15, No 1, 1979 pp 3-16

[Article by I. L. Vilius and A. S. Monin, Institute of Oceanology, USSR
Academy of Sciences]

Abstract. Insolations at different latitudes for the summer and winter caloric half years, created by oscillations in the elements of Earth's orbit for the period from -1 to +1 million years and temporal spectra of the oscillations of these elements, and anomalies of insolation at different latitudes are computed, demonstrated and compared with climate oscillations. Especial attention is focused on the spectral peaks at periods 100,000, 41,000, 23,000, and 19,000 years.

[Text] Numerous comparisons for the course of paleotemperatures and insolations in the Pleistocene that have been made beginning with the known works of Milankovich [1] and until recently (see the bibliography [2-5]) indicate the presence of an analogy between the course of these curves. This analogy is interpreted as proof in support of the astronomical theory of climate oscillations. The latter is based, as is known, on the assumption of the key influence on climate of insolations unambiguously linked to the geometry of planetary orbit.

It goes without saying that an exhaustive response to the question should climate oscillations in the Pleistocene be viewed as forced and as a reaction precisely to oscillations in insolation can be obtained only in numerical experiments in which, with other conditions equal the elements of Earth's orbit will vary. For the present it is expedient to employ a spectral analysis directly for temporal series--perturbed values of Earth's orbit elements and insolation--and compare the findings with the available data on climate oscillations in the Pleistocene, without setting the goal of explaining the mechanism for the reaction of the climate system to the external factor--variation in the orbit elements.

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Such a work, being as if a preparation for the construction of a model of climate oscillations in the Pleistocene, in our opinion is of independent importance. In fact, a spectral analysis provides additional information on the course of the process. Thus, for example, a comparison of the temporal spectra of oscillations in meteorological elements and certain geophysical parameters in the area of periods on the order of tens of years [6, 7] has made it possible to find the similarity of temporal spectra referring to different geological eras--from the Paleozoic era to the modern period.

1. Calculation of Oscillations in Elements of Earth's Orbit

In the framework of the astronomical theory of climate [1] the quantity of solar radiation entering the upper border of the atmosphere, and its distribution over the surface of the sphere is a function of the solar constant S_0 , the large semiaxis of planetary orbit a , period of revolution of the planet around the sun T , as well as three parameters characterizing geometry of the orbit--eccentricity e , slope of the equator towards the ecliptic ε , and longitude of the perihelion of the planetary orbit Π . Thus pinpointing the calculation of insolation can be attained both by means of a more accurate selection of the constants S_0 , a and T , and by means of refining the solution e , ε and Π .

We will briefly examine the technique of calculating Earth's orbit elements. As the main we take the movement obtained during the solution of the problem of two bodies--the examined planet and the sun. Computation of the disturbances imposed on the Keplerian movement as a consequence of interaction with other planets is carried out by the method of successive approximations. With the use of the method proposed by Lagrange the perturbation function is limited by its secular portion (all periodic terms that contain in their arguments mean longitudes or mean anomalies are rejected). In the first approximation during breakdown of the perturbation function terms are considered not above the second order relative to the eccentricities and slopes. Then the solutions (perturbed values of orbital elements) are obtained in the form of trigonometric functions of time. These solutions are useful on a time interval on the order of several millions of years. In order to avoid the difficulties developing in an integration of the Lagrangian equations, when the planetary eccentricity e or inclination i are small, it is customary to replace the variables e, Π, i, Ω (longitude of the ascending point) with the following expressions:

$$\begin{aligned} h &= e \sin \Pi = \sum_k M_k \sin(g_k t + \beta_k), \\ k &= e \cos \Pi = \sum_k M_k \cos(g_k t + \beta_k), \end{aligned} \quad (1)$$

$$\begin{aligned} p &= \sin i \sin \Omega = \sum_k N_k \sin(s_k t + \delta_k), \\ q &= \sin i \cos \Omega = \sum_k N_k \cos(s_k t + \delta_k). \end{aligned} \quad (2)$$

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System (1) is called system (e, Π) , the system (2)--system (i, Ω) . The slope ε can be determined with the help of system (i, Ω) . In the solution for lengthy time intervals it is necessary to consider the effects of precession. The precessional amounts were expressed by Laplace in a trigonometric form with accuracy up to the first degree of eccentricity and slopes. Further the studies of the classics were developed and refined by a number of authors, and used to construct quasiperiodic solutions [8-16]. These works defined the numerical values $M_k, g_k, \beta_k, N_k, s_k, \delta_k$. Publication [11] is the most advanced in technique; it contains considerable refinements as compared to the widely known solution of Brouwer and Woerkom [8], which was refined by Sh. G. Sharaf and N. A. Budnikova [9], and graphically reproduced by Cohen et al. [10]. In Berger's work [12] different variants of solutions are compared among themselves.

A comparison of the solutions that differ only in the values of planetary masses makes it possible to draw a conclusion that a further refinement in the values of planetary masses will not have a significant effect on the calculation accuracy.

For the system (e, Π) the most important are terms of the second order relative to eccentricity and planetary inclinations. At the same time the addition of shorter periodic terms to Lagrange's solution is less important than consideration of the terms of the third order in relation to eccentricity and inclinations. It is important that the solution of Brouwer and Woerkom [8] widely used in climatological applications and including only two short-period terms already has the main features of the solution of Bretagnon [11] where there are 50 such terms.² On the other hand, the system (i, Ω) is more sensitive to terms of the third order in relation to eccentricities and inclinations, while additional terms linked to masses are negligible.

Sh. G. Sharaf and N. A. Budnikova [9] have derived trigonometric formulas for precession with accuracy to the second degree of eccentricity, which when compared with the solution of Laplace limited to the first degree of eccentricity show that for periods of over 1 million years it is necessary to consider additional terms. For periods up to 1 million years in an investigation of the long-period perturbations of slope ε and the overall annual precession it is sufficient to examine the Laplace series which include terms of the first order in relation to eccentricity e , but amplitudes, average velocity, and phases are computed from the solution of Bretagnon (Bretagnon-3) [11], that includes terms of the second order in relation to masses and of the third order in relation to eccentricities and inclinations.

Publication [12] constructs a new solution that includes for the systems (e, Π) and (i, Ω) terms of the second order in relation to perturbing masses and the third order in relation to eccentricities and inclinations. There are still certain potentialities for the further refinement of the solutions. This is primarily use of solutions based not on the theory of secular perturbations, but on the full theory of planetary movements [13]. It is most important to consider the terms linked to the great inequality in movement of Jupiter and Saturn; the terms arising as a consequence of the commensurability of the movement of Venus and Earth can further be included in the calculations.

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To determine the oscillations $\delta\epsilon$ and $-\delta(e \sin \Pi)$ we used the solution of Brouwer and Woerkom [8], refined by Sh. G. Sharaf and N. A. Budnikova [9]. The value S_0 of the solar constant for Earth was taken as equal to $1.94 \text{ cal/cm}^2 \times \text{min}$ (the anomalies of insolation in which we are interested are proportional to S_0 and, consequently, with small changes in the selection S_0 is altered little). As the starting moment the epoch 1950.0 was taken, then $\epsilon_0 = 23.4457^\circ$, $e_0 \sin \Pi_0 = 0.016454$, $e_0 = 0.016751$. All the calculations were made with spacing of 5,000 years for a time interval of 4 million years centered relative to the epoch 1950.0. Thus the calculations encompass a period of the Pleistocene (the border between the Pleistocene and the Pliocene is made by the majority of authors along the paleomagnetic episode of Olduvay, i.e. roughly 1.8 million years ago). The solution [8,9] is presented in an analytical form as a linear combination of trigonometric functions. Consideration for the lunar-solar precession results in the need to use a large number of terms in the series. The solutions for ϵ , e and $e \sin \Pi$ have the appearance

$$e = h' + \sum_{i=1}^{45} A_i \cos(a_i t + b_i), \quad (3)$$

$$e \sin \Pi = \sum_{i=1}^{130} C_i \sin(c_i t + d_i), \quad (4)$$

$$e = F_0 + \sum_{i=1}^{45} F_i \cos(f_i t + g_i). \quad (5)$$

The values of the coefficients in these series given in the cited works show that for ϵ the amplitudes of five terms ($i=1-5$) exceed 0.05 and the main is the period about 41,000 years; in the expression for $e \sin \Pi$ there are four terms ($i=2-5$) with amplitude greater than 0.01, and the main are the periods about 23,000 and 19,000 years; for oscillations and eccentricity e the main is the period about 100,000 years.

A spectral analysis made it possible to reveal more clearly the nature of the secular oscillations in orbital elements. It is apparent from figure 1 that the spectrum $\delta\epsilon$ --unimodal, with peak of the period 41,000 years, in the spectrum $\delta(e \sin \Pi)$ --bimodal--two important precession peaks are found--at periods 23,000 and 19,000. We note that the period of secular oscillations in the eccentricity on the order 100,000 years practically is not manifest in the spectrum of perturbed value of the product $\delta(e \sin \Pi)$. Variations in the orbital elements have a quasiperiodic nature; the calculations made for the period 2 million years ahead (ago) from the epoch 1950.0 provided practically coincident values of the periods. At the same time analysis of the temporal course of orbital elements shows that on individual temporal intervals the dominant periods will differ (especially on the time interval 600,000-1 million years ago, where the values of eccentricity e are very small). The spectrum of the perturbed value of eccentricity of Earth's orbit has the maximum near the period 100,000 years (figure 2).

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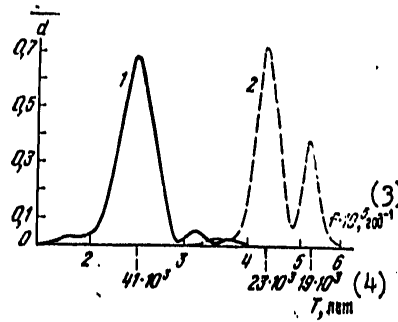


Figure 1. Energy Spectra of Perturbed Values of Earth's Orbital Elements

Key:
 1. δe
 2. $\delta (e \sin \Pi)$
 3. Year⁻¹
 4. Year

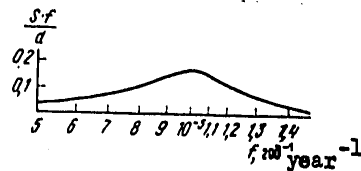


Figure 2. Energy Spectrum of Perturbed Values of Eccentricity of Earth's Orbit

2. Calculation of Insolation Oscillations

We will write, by following [1], the expressions defining the quantity of insolation received by a unit of area at latitude φ during the caloric half years³ in the epoch t for winter and summer of the Northern (Q_{nw} and Q_{ns}) and Southern Hemispheres (Q_{sw} and Q_{ss}):

$$\begin{aligned} Q_{ns} &= W_s + R_s \delta e - m e \sin \Pi, & Q_{sw} &= W_w + R_w \delta e - m e \sin \Pi, \\ Q_{nw} &= W_w + R_w \delta e + m e \sin \Pi, & Q_{ss} &= W_s + R_s \delta e + m e \sin \Pi, \end{aligned} \quad (6)$$

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where W_w , W_s --sums of insolation received by a unit of area at latitude φ during the summer and winter astronomical half years; R_s , R_w --changes in solar insolation with a change in slope by 1° ; m --multiplier depending on latitude φ :

$$m = 2TS_0 \cos \varphi / \pi^2 (1 - e^2)^{3/2} \quad (7)$$

\bar{Q}	φ , град (1)									
	90	80	70	60	50	40	30	20	10	0
\bar{Q}_{sq}	122,02	123,39	127,32	137,13	148,15	156,40	160,89	161,44	157,25	147,99
\bar{Q}_{nw}	0	3,10	12,58	31,20	54,52	77,87	99,78	119,58	135,92	147,99
\bar{Q}_{sw}	0	2,99	12,46	31,12	54,29	77,59	99,48	119,37	135,71	147,80
\bar{Q}_{ns}	122,62	123,34	127,30	136,96	147,92	156,14	160,58	161,36	157,05	147,80

Key:

1. Degrees

If one ignores the second degrees of perturbations in eccentricity and slope, as well as the secular changes S_0 , a and T , then R_s , R_w , W_s , W_w and m will be constant amounts for the given latitude.

We computed the values of insolation (6) with spacings in time of 5,000 years and of latitude 10° for the period -1 million years $\leq t \leq +1$ million years. The mean values of insolation for this period of time $\bar{Q}_{ns}(\varphi)$, $\bar{Q}_{sw}(\varphi)$, $\bar{Q}_{nw}(\varphi)$, and $\bar{Q}_{sq}(\varphi)$ are given in the table. They are the maximum in the summer tropics, slightly decrease towards the summer pole, and decrease to zero towards the winter pole; in the period of the southern summer they are slightly larger everywhere than in the period of the northern summer. Anomalies of insolation were computed according to formulas of the first order of triviality:

$$\begin{aligned} \delta Q_{ns} &= R_s \delta e - m \delta(e \sin \Pi), \\ \delta Q_{sw} &= R_w \delta e - m \delta(e \sin \Pi), \\ \delta Q_{nw} &= R_w \delta e + m \delta(e \sin \Pi), \\ \delta Q_{sq} &= R_s \delta e + m \delta(e \sin \Pi), \end{aligned} \quad (8)$$

in which the multipliers R_s , R_w and m depend on latitude (and are not altered with replacement of φ by $-\varphi$), but δe and $\delta(e \sin \Pi)$ --on time (and are not altered with replacement of the solar longitude λ by $\lambda + \pi$). It is apparent from figure 3 that the coefficient R_s for the influence of the multiplier rises from the equator to the high latitudes (R_w --from the equator to the temperate latitudes), while the coefficient m of the influence of multiplier $\delta(e \sin \Pi)$ rises from the poles to the equator.

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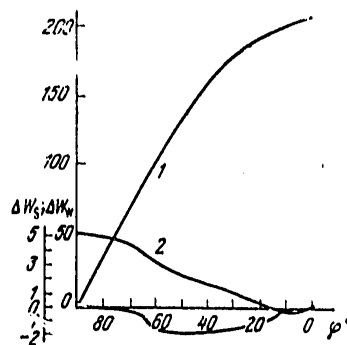


Figure 3. Dependence of m (curve 1), R_g (curve 2) and R_w (curve 3) on Latitude φ

Milankovich [1] and other authors have presented anomalies of insolation (8) by equivalent latitudes $\varphi_*(t, \varphi)$ defined from the correlations $Q(\varphi_*, 0) = Q(\varphi, t)$, and considering that the greatest oscillations between the glacial and nonglacial conditions in the Pleistocene occurred in the temperate latitudes about $\varphi = 65^\circ$ N, limited themselves to computation and demonstration of oscillations in the equivalent latitude $\varphi_*(t; 65^\circ\text{N})$. However here a lot of information dropped out. We will demonstrate here the functions $\delta Q(\varphi, t)$ determined by the formulas (8) completely.

The graphs for the anomalies of insolation (8) for the period of time -1 million years $\leq t \leq +50,000$ years that are the main result of this work are given in figures 4a-4d. The left halves of the graphs provide the distributions of anomalies over the entire earth for the summer half year of the Northern Hemisphere (δQ_{ns} and δQ_{sw}), while the right--for the summer half year of the Southern Hemisphere (δQ_{nw} and δQ_{ss}). The regions of negative anomalies of insolation on the graphs are hatched. The graphs show that anomalies of insolation for the caloric half years reach in the temperate latitudes values up to $\pm 10 \text{ kcal} \times \text{cm}^{-2}$, and are altered in latitude and with time externally irregularly. However in these changes one can note the following two statistical laws.

1. The more intensive component of anomalies of insolation in a fixed season have the same sign over the entire earth, in a fixed hemisphere alter the sign from summer to winter half year (asymmetry of the left and right halves on figures 4a-4d), and quasiperiodicity is observed with a period of about 20,000 years (period $\delta(e \sin \eta)$).

2. A somewhat less intensive component of anomalies of insolation is expressed in the high and temperate latitudes of the summer hemispheres, has a quasiperiodic nature with period about 40,000 years (created by oscillations in the slope of the equator towards the ecliptic), and has the same signs in

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the summer half year both of the Northern and the Southern Hemispheres (symmetry of the left and right halves on figures 4a-4d).

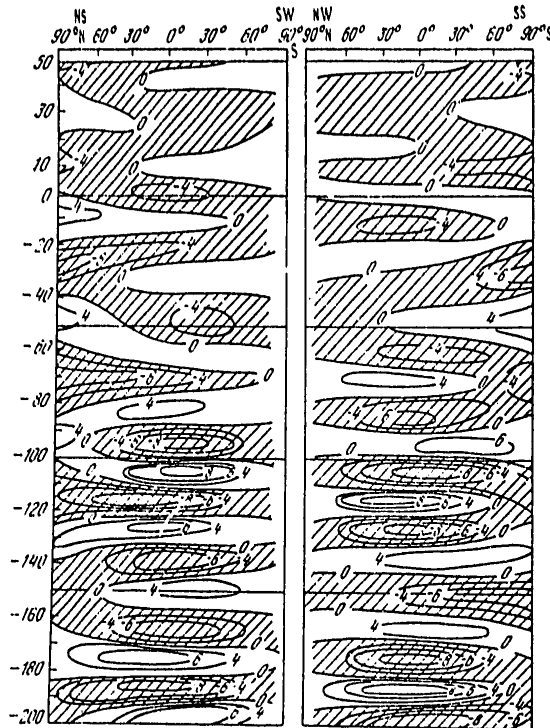


Figure 4a. Anomalies of Insolation for Caloric Half Years (along y axis time in thousands of years)

3. Oscillations in Insolation and Climate

In the literature there is a generally accepted comparison of the temporal course for summer insolation at 60-70°N with the course of different indicators of paleoclimate. At the same time an examination of the entire field of insolation provides significant additional information. It is natural to examine oscillations in solar climate on the territory of the entire globe in correspondence with the global nature of climate oscillations. The presence of such synchronism in the oscillations of climate has been noted many times. We cite the results of a radiocarbon analysis of the values 8018 in the ice core of the station Vostok [17]. The authors note the synchronism of oscillations in climate in the polar regions of both hemispheres. The results of isotope studies of the ice core of the station Vostok were compared with analogous data from Camp Century (Greenland) for the time interval of

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50,000 years. Publication [18] gives a detailed analysis of the data indicating the synchronism of oscillations in climate on the entire globe during the same time interval (50,000 years).

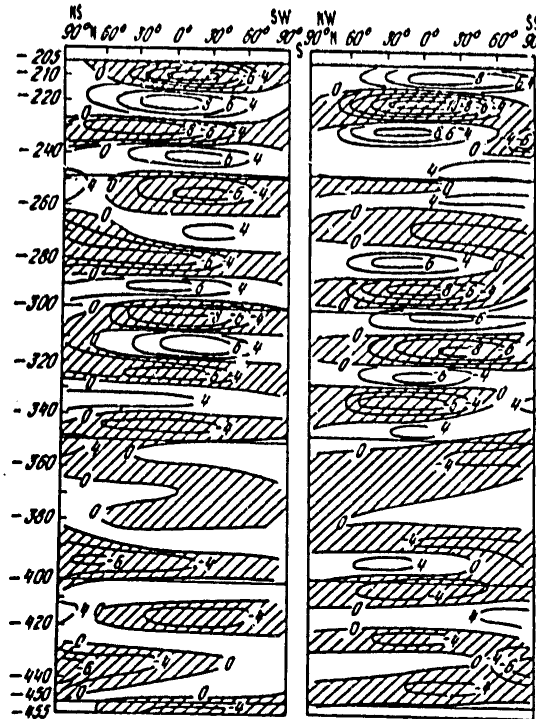


Figure 4b. The Same as Figure 4a for the Period $-455,000 \leq t \leq -205,000$ Years

If in an analysis of oscillations of solar climate one starts from the scheme of Penk and Bryukner for the Alps, then the minimums of insolation in the high and temperate latitudes of the summer hemispheres (figure 4a-4d) can be grouped respectively for 25,000, 70,000 and 115,000 years--to Wurm III, to Wurm II and Wurm I, 190,000 and 230,000 years--to Riss II and Riss I, 435,000 and 475,000--to Mindel II and Mindel I, 550,000-590,000 years--to Gunz; the earlier minimums (685,000, 855,000, and 970,000 years) are comparable to the preGunz or Danube stages of Pleistocene glaciation. In an examination of the anomalies of insolation for an interval up to 1 million years ahead one can isolate distinct minimums at 50,000, 95,000 and 130,000 years, and deeper minimums at 170,000, 215,000, 260,000, 335,000, and 375,000 years comparable in intensity with glaciations of the Gunz type; further the minimums are located at 505,000, 620,000, 715,000, 830,000 (especially deep minimum), 910,000, and 950,000 years. It is apparent from figure 4a that the nearest minimum of insolation (analogous in configuration to the previous minimum of Wurm III,

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but somewhat less intensive, encompasses the now starting 20,000 years and has a peak within 10,000 years, so that from this position the astronomical theory of climate oscillations predicts for the next millenia a cooling off of the climate.

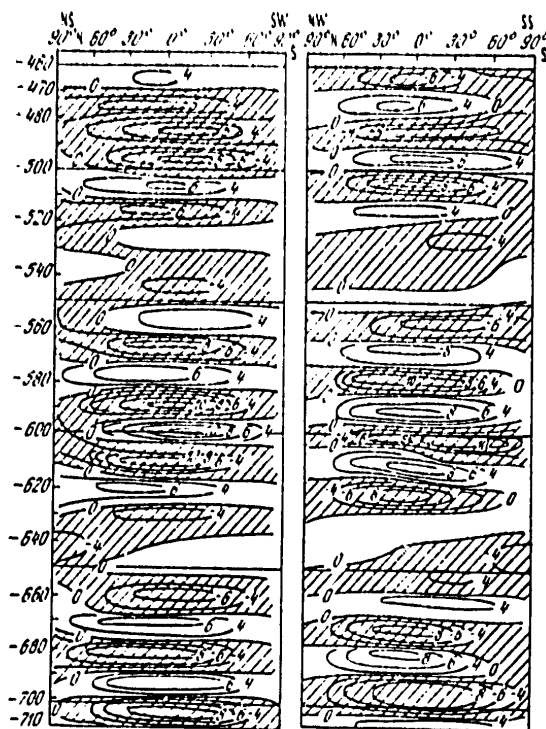


Figure 4c. The Same as in Figure 4a for the Period $-460,000 \leq t \leq 710,000$ Years

We will attempt to compare the data on changes in the solar climate of Earth with the latter Paleogeographic data. It is possible that precisely in the intervals 60-70°N the greatest coolings off with the currently extant arrangement of dry land and sea, relief of dry land and ocean depths elicited the beginning of an intensive rise in glacial sheets, that reached 40°N in North America and 50°N in Europe [19]. In light of this hypothesis it is justified to make a detailed analysis of the course of the insolation curve precisely at 60-70°N. We note first of all that in the most widespread stratigraphic schemes (for example, [20]) the glaciations and interglacial periods are smaller than on the insolation curves. This is possibly explained by the fact that not all the coolings off were accompanied by the spread of glaciers to vast territories (outside Fermo-Scandinavia and Canada) and not all the warmings--by a disappearance of glacial sheets of the temperate latitudes.

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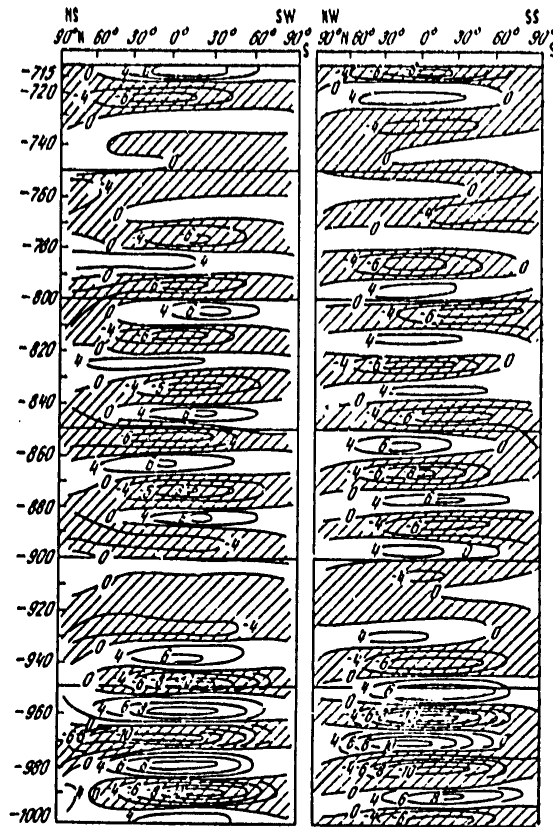


Figure 4d. The Same as in Figure 4a for the Period $-715,000 \leq t \leq -1$ Million Years

The main maximum of the severe continental climate (with pronounced periglacial conditions) existed 25,000-14,000 years ago [20]. In the layers of soil belonging to this time a cold-loving subarctic fauna is found, and intensive accumulation of loess. Glaciations in Siberia 24,000-10,000 years ago [21] belong to this same period. This maximum of glaciation clearly correlates with the minimum on the curve of insolation near 25,000 years. For the maximums that preceded in time the link remains more hypothetical but completely probable. The close correspondence with the Paleotemperature curve, and consequently, also with the curve of insolation is found in investigating the aeolian particles in the cores of the Equatorial Atlantic [29] (during the cooling off the Sahara Desert became drier and the removal of dust from it intensified). Analysis of the dating of ancient shorelines formed during

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the interglacial and interstage rises in the ocean level [30] also finds a similarity with the course of the insolation curve.

4. Spectra of Insolation Oscillations

Figures 5 and 6 present the energy temporal spectra $fS(f)$ of oscillations in the summer insolation in the Northern Hemisphere that we computed. In the high latitudes ($90-70^\circ$) in the summer caloric half year oscillations dominate with the period of 41,000 years, and the spectra are practically unimodal. At 60° there are two peaks that practically coincide in height--at 41,000 and 23,000 years, and a smaller peak at 19,000 years. Starting with latitude 50° , periods dominate of 23,000 and 19,000 years. The weakest peak at the period 41,000 years practically disappears in the lower latitudes. For the winter caloric half year a peak dominates at 23,000 years, and there is a smaller peak at 19,000 years. Starting with latitude 30° a peak appears near 41,000 years which again disappears starting with 70° . We note that the resolution of the spectral analysis is fairly high. Thus, for example, a very weak peak is found near the period 100,000 years on the spectrum $\delta(e \sin \Gamma)$. This very weak peak is found also in the spectra of summer insolation on the lower latitudes.

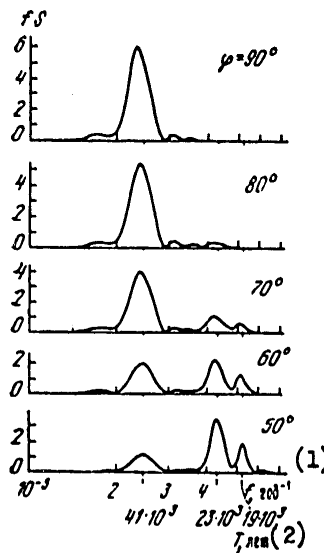


Figure 5. Energy Spectra of Oscillations of Insolation δQ_{ns} at Latitudes from 90 to 50°

Key:

1. Year⁻¹

2. Year

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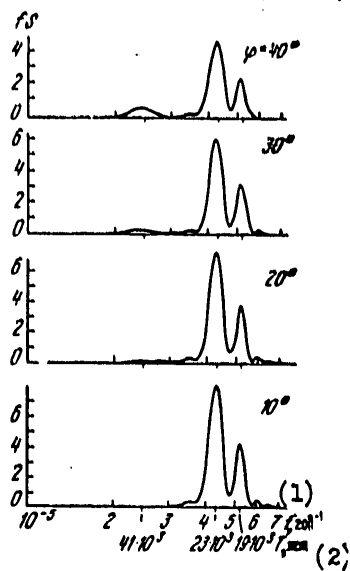


Figure 6. Energy Spectra of Oscillations of Insolation δQ_{ms} at Latitudes from 40 to 10°

Key:

1. Year⁻¹

2. Year

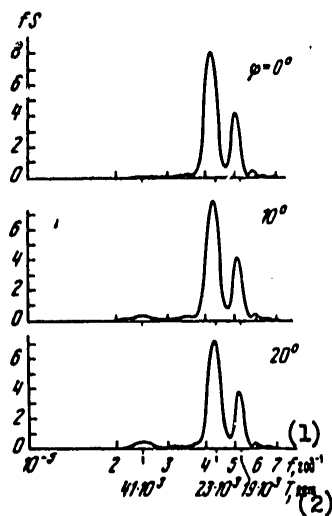


Figure 7. Energy Spectra of Oscillations of Insolation δQ_{sw} at Latitudes from Zero to 20°

1. Year⁻¹

2. Year

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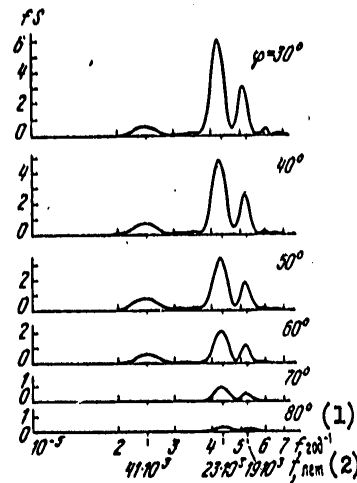


Figure 8. Energy Spectra of Oscillations of Insolation δQ_{sw} at Latitudes from 30 to 80°

Key:

1. Year⁻¹

2. Year

5. Spectra of Climate Indicators

We will compare the findings with the known published spectra of oscillations in climate characteristics in the Pleistocene. Publication [31] presents oscillation of values δO^{18} in cavities of plankton in the layers of the core of deep-water deposits from the Pacific Ocean in the last million years reflecting the global volume of ice on Earth. Analysis of these results makes it possible to draw the conclusion that in the last 600,000 years the continental glaciations were formed and melted away on the average with a period of about 100,000 years. The spectrum constructed from these data reveals a distinct maximum near the period about 100,000 years.

Publication [4] has restored the absolute geochronology for the last 468,000 years of three climate indicators in two cores of sea deposits from the central region of the Indian Ocean at latitudes 43-46°S. The first indicator was the relative content of heavy isotope of oxygen δO^{18} in the cavities of plankton Foraminifera, reflecting changes in the isotope composition of sea water due to the accumulation and melting of continental ice sheets; the second indicator--the species composition of communities of Radiolaria--reflected oscillations in temperature in the upper layer of the ocean; the third--relative content of Radiolaria of the species *Cycladophora daviziana*--reflected oscillations in water salinity. The spectra computed for these

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orders contain distinct maximums near the periods 100,000, 42,000, 23,000 and 19,000 years (although the peak near the period 100,000 years was also located on the low-frequency end of the spectrum, i.e., was estimated more roughly, it is statistically important). Thus the maximums lie near the main periods characteristic for the secular oscillations in the eccentricity, slope and precession which serves as a decisive proof in favor of the astronomical theory of climate oscillations. Parallel in [4] spectra were computed δQ_{sw} and δQ_{ns} for latitudes 55°S and 60°N, whereby the solution of Berger [16] was used to calculate the secular oscillations in orbital elements. Despite the fact that the process has a quasiperiodic nature, the spectra of insolation [4] and the spectra computed by us for the time interval 2 million years are identical. The nature of the spectra of equivalent latitudes 65°S and 65°N (winter and summer, duration of the series 5 million years) is identical to the corresponding spectra of insolation (spectra of equivalent latitudes were computed by us previously from data kindly presented by Sh. G. Sharaf). The authors [4] noted the absence of a maximum on the spectra of insolation near the period 100,000 years. This circumstance can be easily explained if one starts from an analysis of the solution for $\delta(e \sin \pi t)$ (see above).

The finding of a maximum near the period 100,000 years in the spectra of climate indicators is of significant importance. The proximity of the dominant frequencies for the temporal series of eccentricity and climate characteristics was also noted previously [32, 33]. In publication [34] for the last 1.8 million years oscillations in paleoclimate, characteristics of intensity of the earth's magnetic field, and variations in the eccentricity of the earth's orbit were compared among themselves. The work analyzes six series of deep-water sea deposits. Periods of warm climate and low intensity of the earth's magnetic field generally coincide with the periods of large value of eccentricity. Analysis of a series of cores of deep-water deposits [35] at depths 2,900-4,000 m, which contains almost a complete cross section of late Quaternary deposits reveals the periodicity on the order 100,000 years in the deposits of carbonates. The radiocarbon analysis shows that a low content of carbonates is characteristic for the glacial episodes.

Publication [4] to explain the peak near the period 100,000 years in the spectra of deep-water sea deposits advances another hypothesis--on the presence of a nonlinear link between oscillations in the elements of Earth's orbit and climate oscillations. This question is discussed in detail in [36]. In the presence of a nonlinear reaction of the climate system oscillations in insolation with frequencies ω_1 and ω_2 provide climate oscillations with frequency $\omega_1 + \omega_2$ (the linear section of the reaction reproduces at the outlet frequencies ω_1 and ω_2 without changes). Then the nonlinear interaction provides at the outlet a signal with period on the order 100,000 years (term $\omega_1 - \omega_2$) governed by the peaks at the inlet near the periods 23,000 and 19,000 years. In the spectra of the climate indicators peaks are also found near the periods 41,000 and 23,000 years, therefore the reaction of the climate apparently has both nonlinear and linear components. It should be noted that the peak near the period 10,000 years corresponding also to the nonlinear component of climate reaction (term $\omega_1 + \omega_2$) is not found in the spectra [4], that is clearly manifest in the spectra of other series (for example, the cores of ice from Camp Century).

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The results of a spectral analysis makes it possible to draw a conclusion (see [3]) that the successive states of climate are correlated, and the system atmosphere-ocean-dry land possesses "memory devices" (ice sheets) so that on the scales of tens of millenia the behavior of the system atmosphere-ocean-dry land can be predicted from its prehistory.

The authors thank V. A. Brumberg, Sh. G. Sharaf and D. D. Kvasov for useful discussions.

FOOTNOTES

1. Secular changes S_0 , a and T are so insignificant that they can be ignored.
2. The values computed from [8 and 11] of eccentricity differ by not more than 20% (time interval 300,000 years ago).
3. We recall that the diurnal insolation at a certain latitude ϕ on any summer day of the caloric half year is greater than the diurnal insolation at the same latitude in the winter caloric half year, and the duration of the caloric half year in contrast to the astronomical does not alter with time and equals $T/2$.

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GEOPHYSICS, ASTRONOMY AND SPACE

FRENCH METALLURGY EXPERIMENTS ABOARD 'SALYUT-6'

Paris AIR ET COSMOS in French 31 Mar 79 p 52

[Article: "French Experiments in Space Metallurgy on Board 'Salyut-6'"]

[Text] Ten French experiments in metallurgy under conditions of weightlessness of the "ELMA" program are going to be carried out within the framework of the Franco-Soviet spatial cooperation, prepared by French scientific laboratories on board the orbital station "Salyut-6."

These experiments, which began on 25 March, using the first samples brought by the Soviet cargo vessel "Progress V," will be carried out--like all successive ones--in the Soviet ovens "Splav" and "Kristal" of the station. The crew of the "Salyut-6" will put into the ovens cartridges containing samples of materials and will attend to programming the ovens' operations. The duration of the cycles of temperature will extend from few hours to several tens of hours; the samples will then be brought back to the ground and analyzed by the experimental laboratories.

The experiments will deal with, on the one hand, the growth of crystals, starting from the gaseous phase, and from the liquid or liquid solution phase. The problem is to study, under the conditions of microgravity existing on board the "Salyut-6," the formation of different types of monocystals starting from liquid spheres placed in position: cellular and dendritic solidification of aluminum or tin-based alloys, the synthesis of alloys with magnetic properties based on rare earths (neodyme-cobalt and cerium-manganese compounds), and the growth of germanium in the gaseous phase.

They are also concerned with the formation of semi-conductors with monocystals: From the spatial environment and the absence of convection in fluids a better control of conditions of crystal growth is expected, leading to an improvement in the quality of the crystals. The materials studied are oxyde of vanadium, gallium arsenious compounds, and phosphorus alloyed with gallium and with indium.

The experiments were prepared by the Solid Chemistry Laboratories of the CNRS [National Scientific Research Center] in Bordeaux, the Diffusion and Technology of Material Service of the CNRS in Meudon-Bellevue, the laboratory of the Physics of Solidification of the Institute of Fundamental Research of the CEA in Grenoble and the Laboratory of Magnetism of the CNRS in Grenoble.

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IMPROVING THE EFFICIENCY OF THE UTILIZATION OF URANIUM IN THE RBMK-1000

Moscow ATOMNAYA ENERGIYA in Russian Vol 46 No 3, Mar 79 pp 139-141 manuscript received 17 Jul 78

[Article by I.Ya. Yemel'yanov, A.D. Zhirnov, V.I. Pushkarev and A.P. Sirotkin]

[Text] Increasing unit power is one of the ways of improving the economic effectiveness of an AES. As applied to RBMK's [high-power channel reactors], this has been reflected in the development of the RBMK-1500, RBMK-2000 and RBMKP-2400. The ability to increase the capacity of an RBMK-1000 channel by a factor of 1.5 by the intensification of heat exchange has been realized in the RBMK-1500, where the power has thereby been increased to 1500 MW (electrical) without changing the overall dimensions and design of the reactor. In the design for the RBMK-2000 the diameter of the channel was increased, along with the number of fuel elements in it and the lattice spacing, which has made it possible to develop within the overall dimensions of the RBMK-1000 a reactor of double the power, 2000 MW (electrical). The creation of an increased-capacity channel has opened up new opportunities for improving technical and economic characteristics, such as increasing the degree of burnup and reducing the consumption of TVS's [fuel assemblies] and the specific consumption of natural uranium.

The experience of utilizing uranium-graphite reactors [1, 2] has demonstrated that it is possible for the fuel in them to be reloaded continuously in operation. This has made it possible to avoid considerable changes in reactivity in the process of the reactor's operation, to reduce the unproductive capture of neutrons in control rods, and thereby to increase the integral power generation and degree of fuel burnup with low enrichment of uranium. As demonstrated by physical and technical and economic estimates for an RBMK-1000 [3, 4], with the current cost of fuel and of making fuel elements, the minimal fuel component of imputed costs for the generation of electric power, z_c , occurs with initial enrichment of 1.8 to two percent. Meanwhile, it has been proven by calculations that with greater enrichment and with the reactor operating in the continuous reloading mode the capacity of freshly loaded channels is increased and the length of time the fuel remains in the reactor is extended. On the basis of the available data, and taking into account the fact that, first, there had not been sufficient experience in the utilization of fuel

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elements with a high degree of burnup (approximately 25 to 30 MW·day/kg U) with linear loads of 300 to 400 W/cm and a five-year period for remaining in the reactor, and, second, the minimum for z_t had been expressed loosely, the relatively conservative decision was made to use fuel with a 1.8-percent enrichment (table 1) in the RBMK-1000 for the steady-state continuous reloading mode. The employment of z_t as the optimization criterion is to a certain extent arbitrary.

Table 1. Characteristics of a Reactor When Using Fuel with the Rated and an Increased Degree of Enrichment

1) Показатель		2) RBMK-1000					3) RBMK-1500	
4)	Начальное обогащение, %	1,8	2,0	2,4	3,0	3,6	1,8	2,0
5)	Глубина выгорания топлива, МВт·сут/кг U	18,5	22,3	28,8	37,6	45,7	17,8	21,6
6)	Состав выгружаемого топлива, кг/т:							
	235U	3,9	3,5	2,9	2,5	2,2	4,4	3,8
	238U	2,1	2,5	3,1	4,0	4,8	2,1	2,4
	239Pu	2,2	2,2	2,2	2,1	2,1	2,2	2,2
	240Pu	1,8	2,0	2,3	2,5	2,6	1,8	2,0
	241Pu	0,5	0,5	0,6	0,6	0,7	0,5	0,5
7)	шлак	19,4	23,3	30,1	39,3	47,8	18,6	22,8
8)	Изменение α_ϕ по отношению к проектному, %	—	-1,3	-3,5	-0,4	-9,0	-1,5	-2,7
9)	Расход урана, т/год·ГВт(эл.) при $\phi=0,8$: обогащенного	50,5	42	32,5	25	20,5	52,4	43,3
10)	природного	169	158	151	148	148	174	165
11)	Потребность в топливе, 10^3 год/ГВт (эл.)	16	13,3	10,2	7,9	6,5	16,5	13,6
12)	при $\phi=0,8$							
13)	Топливная составляющая: себестоимости электроэнергии, коп./((кВт·ч)	0,252	0,232	0,216	0,208	0,208	0,260	0,240
14)	коп./((кВт·ч)							
15)	приведенных затрат z_t , коп./((кВт·ч)	0,370	0,362	0,370	0,405	0,445	0,335	0,325

Key:

- | | |
|---|--|
| 1. Indicator | 11. Natural |
| 2. RBMK-1000 | 12. Fuel element requirement, 10^3 year/ |
| 3. RBMK-1500 | /GW (elec.), with $\phi = 0.8$ |
| 4. Initial enrichment, % | 13. Fuel component: |
| 5. Degree of fuel burnup, MW·day/kg U | 14. Of cost of electric power, in |
| 6. Composition of unloaded fuel, kg/t: | kopecks/kWh |
| 7. Slag | 15. Of imputed costs, z_t , in kopecks/ |
| 8. Change in α_ϕ in relation to rated, % | /kWh |
| 9. Consumption of uranium, t/year·GW (elec.), with $\phi = 0.8$: | |
| 10. Enriched | |

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The experience in operating the first RBMK-1000's has demonstrated that the fuel element and TVS design which has been created has a definite potential, both in terms of linear loads on fuel elements and of the ultimate capacity (in relation to critical heat exchange conditions) of the channel. In addition, the stability of power distribution is reduced in proportion to the burnup of fuel and the removal from the reactor of supplementary absorbers compensating the initial excess reactivity. As demonstrated by calculations and confirmed by experiments, a positive void coefficient, α_ϕ , basically determines the modification of energy release fields with a time constant for the first azimuthal harmonic of from a few minutes to a few dozen minutes. Its reduction makes the power distribution more stable. The most economical and optimal reduction of the void coefficient and improvement of the stability of power distribution in an RBMK are achieved by increasing the ratio of fuel nuclei to moderator nuclei. Improvements in the ratio of fuel and moderator nuclei in operating reactors are achieved by increasing the enrichment, and in reactors being designed it is possible to reduce the moderator nuclei, e.g., by reducing the lattice spacing or the effective density of the moderator.

Increasing the degree of fuel enrichment results in an increase in the degree of fuel burnup and in modification of α_ϕ improving field stability, and in a reduction in the consumption of fuel and fuel elements. An increase in the degree of enrichment and the improvement in the degree of burnup in keeping with it in turn are responsible for an increase in the capacity of a freshly loaded channel, in the length of time the fuel stays in the reactor, and in linear loads on a fuel element. The feasibility of increasing the capacity of a channel by a factor of 1.5 has been confirmed by the creation of the RBMK-1500 channel. The data presented in table 2 must be regarded mainly as comparative, and not absolute, for the calculations were performed for the steady-state fuel reloading mode. In determining the capacity of live channels, variation factors k_r and k_z were used, gotten by taking into account the experience in utilizing the RBMK-1000, and calculated reloading factors. For reactors operating with fuel with 1.8-percent enrichment, the variation factor for the radius, k_r , was assumed to equal 1.4, and the variation factor for the height, k_z , 1.4 also. On the basis of the experience in utilizing the RBMK-1000, the root-mean-square error in determining and maintaining the channel capacity, σ_k , was assumed to equal 5.2 percent, and the linear load on a fuel element, σ_L , 7.7 percent. In calculating the annual consumption of natural and enriched fuel it was assumed that the load factor, ϕ , equaled 0.8 and the content of ^{235}U in an enrichment plant dump, 0.25 percent. The return of ^{235}U from spent fuel into the fuel cycle was not taken into account. Thus, increasing the enrichment of fuel in an RBMK-1000 is a realistic method of improving the efficiency of its utilization. Furthermore, from the viewpoint of permissible channel capacities and linear loads on a fuel element, enrichment as much as 3.6 percent is possible. A solution to increasing the capacity of the channel and linear loads on a fuel element by as much as a factor of 1.5 has been found in the RBMK-1500 [5, 6]. In this case the TVS's were supplied with heat exchange intensifiers. There are no changes in the design of the channel or in delivery and discharge lines. With a more moderate increase in enrichment and, consequently, channel capacity, TVS's without

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intensifiers can be used. For example, it is possible to convert to two-percent enrichment of fuel without any design changes in TVS's. The maximum values of capacities presented in table 2 were obtained on the assumption that the power equalization algorithm for the core is kept the same as in existing RBMK-1000's. In addition, measures can be suggested (some of which have already undergone experimental verification with reactors) which make it possible to broaden the ability to equalize the distribution of power in the core. Under this heading can come the utilization of absorbing rods loaded into fresh TVS's and removed as the power of the channel is reduced, the application of absorbers which burn up, optimization of the reloading procedure, and the like. A definite potential for the equalization of power distribution is entailed in a possible increase in the operating reactivity margin caused by the mode of operation of the AES in the power system.

Table 2. Power of Channel and Linear Load on Fuel Element as a Function of Degree of Enrichment of Loaded Fuel

1) Характеристика		2) RBMK-1000					3) RBMK-1500	
4)	Обогащение, %	1,8	2,0	2,4	3,0	3,6	1,8	2,0
5)	Мощность свежезагруженного канала с учетом k_r , кВт	2650	2800	3150	3500	3800	4050	4250
6)	Предельная мощность канала с учетом $3\sigma_k$, кВт	3050	3250	3650	4050	4350	4650	4910
7)	Линейная нагрузка на топливную связку в свежезагруженном канале q_k^{nom} , Вт/см	295	315	350	390	420	455	485
8)	Предельное значение q_k с учетом $3\sigma_k$, Вт/см	360	385	430	480	520	560	595
9)	Комбинация ТВС, эф. сут	1100	1350	1730	2260	2750	7(а)	860

Key:

1. Characteristic
2. RBMK-1000
3. RBMK-1500
4. Enrichment, %
5. Capacity of newly loaded channel, taking into account k_r , in kW
6. Ultimate capacity of channel, taking into account $3\sigma_k$, in kW
7. Linear load on fuel element in newly loaded channel, q_k^{nom} , in W/cm
8. Limiting value of q_k , taking into account $3\sigma_k$, in W/cm
9. TVS operating period, eff. days

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Increasing the enrichment results in a reduction in the consumption of fuel elements and natural uranium. The annual consumption of fuel elements in shifting from variant to variant is reduced by 20 to 30 percent, and is reduced twofold when employing three-percent enrichment. The consumption of natural uranium with this degree of enrichment is reduced by 20 tons and equals 150 tons per year. The content of ^{235}U in spent fuel is reduced to 0.25 percent, i.e., to the amount of enrichment plant dumps, and when 3.6-percent enrichment is employed, to 0.2 percent, which eliminates the question of the necessity of extracting it from the spent fuel. Increasing the initial enrichment considerably alters the void coefficient, reducing it in comparison with 1.8-percent enrichment and shifting it to the negative side. This improves the stability of power distribution, but requires special consideration under transient conditions.

Whereas alteration of these parameters (channel capacity, linear load on fuel element, change in void coefficient) does not give rise to doubts regarding the ability to increase the enrichment, increasing the degree of burnup to 40 to 45 MW·day/kg U and the calendar period for the fuel elements to remain in the core to 10 to 12 years with three- and 3.6-percent enrichment, respectively, requires special research and confirmation, although the creation of fuel elements with an oxide fuel burnup of 45 to 50 MW·day/kg U can be considered realistic [7, 8]. It is more difficult to ensure the vitality of fuel elements under reactor conditions over an extended period.

Increasing the capacity of the channel by a factor of 1.5 has unveiled new prospects for the RBMK-1000 and has substantially improved the economic indicators of the fuel cycle on account of the increase in the degree of fuel enrichment. The utilization in the RBMK-1000 of fuel with 2.4- to three-percent enrichment requires the creation of and the experimental confirmation of the efficiency of fuel elements enabling a degree of burnup of 40 MW·day/kg U and having a guaranteed life of about 10 years in the core. This represents one line along which experimental design and research work must be done with regard to improving the RBMK-1000.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

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HISTORY OF MOSCOW GEOLOGICAL EXPLORATION INSTITUTE

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[Article by D. P. Lobanov: "Sixtieth Anniversary of the Moscow Geological Exploration Institute imeni Sergo Ordzhonikidze"]

[Text] Early in 1919, the most difficult year of the struggle against the enemies of the revolution, a ceremony was held opening the Moscow Mining Academy (MGA). The first students began studying in its departments of geological exploration, mining, and metallurgy. This unique higher educational institution, a child of Great October, was established by the 4 September 1918 Decree of the Soviet of People's Commissars thanks to the exceptional far-sightedness of V. I. Lenin. Better than anyone else he saw clearly that future successes in the development of industry required timely preparation of engineering and scientific workers in the fields of exploration, exploitation, and processing of mineral raw materials. The establishment of the Moscow Mining Academy and preparation of highly qualified mining geological specialists at it played an enormous part in the development of mineral products in the young Republic of Soviets and served the cause of furthering mining geological education in our country.

Sixty years have passed already since that unforgettable, heroic time. But the greater the time that separates us from the sources of Vladimir Il'ich Lenin's many remarkable initiatives, the greater the need of the heirs of this majestic history to relate how the behests of the great leader are being carried out.

The collective of the Moscow Geological Exploration Institute (MGRI) is carrying on and multiplying the glorious traditions of its parent institution, the department of geological exploration of MGA and its outstanding pedagogs and teachers. Widely recognized and invaluable contributions to the early development of MGA and the development of geological exploration education were made by world-famous scientists, committed people who fought to carry out Lenin's ideas of developing our country's natural resources: academicians I. M. Gubkin, V. A. Obruchev, and A. D. Arkhangel'skiy, corresponding member of the Academy of Sciences USSR N. M. Fedorovskiy, professors

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and teachers G. F. Mirchink, A. A. Gapeyev, M. A. Bolkhovitinova, A. M. Zhirmunskiy, F. P. Savarenskiy, M. M. Zhukov, V. I. Luchitskiy, G. N. Kamenskiy, Ye. V. Milanovskiy, N. S. Shatskiy, M. S. Shvetsov, A. N. Mazarovich, A. I. Zaborovskiy, O. K. Lange, M. V. Sergeyev, and many other outstanding geologists.

Prominent geological scientists such as A. P. Pavlov, V. I. Vernadskiy, A. Ye. Fersman, A. P. Karpinskiy, M. V. Pavlova, I. M. Mushketov, A. N. Zavaritskiy, S. S. Smirnov, M. A. Usov, and many others took active parts in shaping the first syllabi, curricula, and courses and in developing teaching methods. Their scientific ideas have now been greatly elaborated, but they continue to have an important influence on the training of engineering and scientific specialists. We will always remember the constant attention that the Moscow Mining Academy, an important sector of the struggle for the victory of the October Revolution, received from leaders of the party and government such as comrades M. I. Kalinin, A. V. Lunacharskiy, S. M. Budenny, and other political figures of the 1920's. Their remarkable speeches in the halls of MGA were a real education in revolution for the students and teachers.

At a ceremony on 12 February 1923 dedicated to the fourth anniversary of MGA, honorary student M. I. Kalinin said, "This is a new front, a front of conquest, to conquer heavy industry. A great deal depends on what you are like when you leave this Academy." And the graduates of MGA indeed contributed a great deal to the final victory of the October Revolution, laid the foundation of heavy industry, and by heroic labor brought the great Lenin's designs to reality.

For graduates of MGA-MGRI in all subsequent years the challenges of building socialism and communism in our country grew steadily more complex. The scale of mining geological work increased rapidly and they were always assisted by the glorious history of their predecessors and the enormous attention given by the Communist Party to problems of developing the mineral raw material base in all stages. Overcoming inconceivable difficulties caused by the economic devastation which was inherited from Old Russia and the Civil War, in its first 10 years the geological exploration department graduated 290 Soviet mining engineering geologists. This is an impressive figure if one bears in mind that in 1912 the entire Russian Empire had just 565 specialists in the field of geology, and only about 250 specialists in mining geology and geological exploration. We take pride today in noting that among the graduates of MGA in those years were the remarkable pedagogs B. I. Vozdvizhenskiy, B. Ya. Merenkov, A. M. Ovchinnikov, D. I. Shchegolev, Ye. Ye. Zakharov, G. N. Popov, S. S. Panchev, S. M. Shorokhov, and A. I. Milovanov.

A decision of the Presidium of the All-Union Soviet of People's Commissars in April 1930 reorganized MGA into six independent institutes: geological exploration, mining, petroleum, nonferrous metals, steel,

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and peat. This was an objective reflection of the swift growth of our socialist industry and agriculture and the country's steadily growing need for engineering and scientific specialists. Within the group of six institutes, the Moscow Geological Exploration Institute, which added the geological division from Moscow State University, has since that time performed the honorable and important role of academic, scientific, and methodological center of geological exploration education in the country and the only specialized higher educational institution that trains engineers with unique specializations and specializations in the fields of geology, techniques of exploration and working nonferrous ores, rare and radioactive metals, radio hydrogeology, engineering geology, nuclear geophysics, economics of mineral raw materials, and geotechnology.

Taking over from MGA, the collective of MGRI set out with enormous energy and enthusiasm to fulfill the Motherland's new assignments for training mining engineering geologists and took an active part in prospecting for and exploration of mineral raw materials for industrial needs. A major event for the institute took place in 1932 when it was given the famous name of Sergo Ordzhonikidze, who all his life set a brilliant example of selfless service to the working people and tireless struggle for the happiness and freedom of the Soviet Union and building a communist society in our country. The collective of MGRI remembers today and will always remember this date and the name Sergo, which is associated with those years of extremely difficult struggle and joyous triumph for our people, as a small, priceless fragment of those heroic years, as a glorious revolutionary memorial and mandate to justify the party's trust.

During the 10 years of 1930-1940 the four departments of MGRI, geology, exploration, hydrogeology, and geophysics, trained 1,241 geological exploration specialists and 18 candidates of geological-mineralogical sciences. These first results of the independent work of MGRI are inseparably bound to the names of the outstanding geological scientists V. I. Smirnov, G. A. Gamburtsev, P. P. Lazarev, V. V. Mener, V. M. Kreyter, A. A. Yakzhin, Ye. A. Kuznetsov, A. A. Bogdanov, V. S. Koptev-Dvornikov, V. T. Ter-Oganezov, Ye. Ye. Zakharov, P. V. Kalinin, V. N. Pavlinov, Ye. V. Shantser, S. M. Chernyshov, Ye. Ye. Flint, N. I. Nikolayev, B. L. Stepanov, N. I. Kulichikhin, P. P. Pilipenko, I. A. Snobkov, A. I. Kravtsov, A. A. Trofimov, I. V. Garmonov, N. A. Smol'yaninov, M. I. Kalganov, A. I. Zaborovskiy, V. I. Baranov, L. M. Al'pin, N. V. Kolomenskiy, A. G. Tarkhov, and MGA graduates B. I. Vozdvizhenskiy, B. Ya. Merenkov, and A. M. Ovchinnikov.

In November of the war year of 1941 the institute was evacuated to the city of Semipalatinsk, where it continued to perform its primary mission of training engineering specialists. Teachers and students worked with tripled energy to do everything they could to provide necessary metal for the front. In the very first days of the Great Patriotic War a significant number of the students and teachers left for the front and showed heroism and courage in the defense of our

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beloved Motherland. The memorial Plaque of Memory and Glory in the main building of the institute is an eternal reminder of the sacrifices made during the extremely difficult war years of 1941-45. Every precious name of an MGRI graduate written on this granite Plaque calls us all, the living heirs of their glory, to selfless labor, heroic feats, and constant readiness to defend our beloved Motherland as skillfully and courageously as our comrades did in the 1940's.

After our great victory over fascism the institute entered a time of great expansion and improvement in forms and methods of training specialists, strengthening scientific ties with institutes of the Academy of Sciences USSR and production organizations, and development of extensive socially useful work in the city of Moscow. In 1947 a new specialization, "Equipment and Technology of Geological Exploration," was born at the institute and later spread to other higher educational institutions in the country thanks to the fruitful activities of honored scientists of the RSFSR N. I. Kulichikhin, V. M. Kreyter, and S. A. Volkov and honored geologist of the RSFSR B. I. Vozdvizhenskiy. The specialization of engineering geophysicist for nuclear radiometric methods of exploration and engineer-geologist for radioactive metals was begun.

By 1963 MGRI had provided 6,049 mining engineer-geologists for the national economy and they had done an outstanding job in performing the very important assignments of expanding the country's mineral raw material base.

In the fall of 1963 the mining geology school of the Moscow Institute of Nonferrous Metals and Gold imeni M. I. Kalinin (MITsMiZ) was merged with the Moscow Geological Exploration Institute. Like MGRI this institute had its origins in MGA and it trained mining engineers in mining geology and the exploration and working of deposits of non-ferrous ores and rare and radioactive metals. The formation and development of this school is linked to the famous names of academicians A. G. Betekhtin, N. V. Nikolayev, and V. I. Smirnov, corresponding members of the Academy of Sciences USSR M. I. Agoshkov, B. V. Nekrasov, and I. N. Plaksin, professors V. M. Kreyter, M. F. Strelkin, F. I. Vol'fson, V. N. Kotlyar, A. B. Kazhdan, A. F. Sukhanov, B. P. Bogolyubov, S. P. Prokop'yev, Ya. G. Kaplun, V. I. Kiselev, V. S. Makarov, S. I. Pol'kin, S. A. Pervushin, and S. Ya. Rachkovskiy, and MGA graduates A. I. Milovanov, S. S. Panchev, G. N. Popov, D. I. Shchegolev, and S. M. Shorokhov. Between 1930 and 1963 MITsMiZ trained 2,603 mining engineers in this specialization.

The joining of the two schools (MGRI and MITsMiZ) made it possible to significantly step up the training of specialists in the fields of exploration of deposits of rare and radioactive metals, nuclear radiometric techniques in geology, and exploitation of radioactive raw material, fields in which there was a critical shortage of specialists, and also to substantially change the system of training for all specialists toward a comprehensive approach to evaluating the use of raw material resources.

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By its 50th anniversary the collective of the institute had made noteworthy achievements (see this journal, No 6 for 1969) and contributed significantly to the training of engineering and scientific-pedagogical cadres and to the development of scientific research. For this an Ukase of the Presidium of the USSR Supreme Soviet on 12 May 1969 awarded the Order of the Labor Red Banner to the institute. This high honor was received with enormous enthusiasm and called forth a new surge of creative energy and striving to achieve more and make a further contribution to the struggle of the Soviet people to build communism in our country.

All the activity of the institute collective in the last decade (1968-1978) has been influenced by the unprecedented scale of socialist building with its grandiose quantitative and qualitative challenges, the country's steadily growing need for mineral raw materials, and the creative plans of the Communist Party of the Soviet Union for the Ninth and Tenth five-year plans. In its glorious 60 years MGRI has trained 16,100 specialists (5,100 of them in the last decade) with top qualifications in the fields of geological surveying and prospecting for mineral products, mining geology and exploitation of deposits of nonferrous ores and rare and radioactive metals, hydrogeology and engineering geology, geophysical methods of prospecting and exploration, exploration equipment, exploitation of deposits of ores of rare and radioactive metals, and the economics of geological exploration and mining work. In these same years the institute has trained about 1,000 engineer-geologists for 56 socialist and developing countries.

The most significant and satisfying of all the achievements in which the institute takes justified pride today is the success of MGRI graduates, who are working in virtually all sectors of our country's economy. Our graduates P. Ya. Antropov, Ye. A. Kozlovskiy, A. Ye. Kharlamov, N. F. D'yakonov, S. A. Smirnov, N. P. Laverov, V. G. Gazenko, F. G. Leshkov, A. F. Galkin, M. A. Maksimov, N. N. Baryshnikov, G. Gil'manov, and many other comrades are performing important party and state work.

The work of MGRI graduates P. Ya. Antropov, A. V. Peyve, G. A. Selyatitskiy, A. A. Petrov, S. S. Panchev, R. V. Nifontov, M. K. Bupzhanov, N. K. Zhaksybayev, and U. F. Akhmedsafin has been rewarded by granting of the title Hero of Socialist Labor. More than 130 graduates of the institute have been honored as winners of the Lenin (P. Ya. Antropov, A. V. Peyve, Ye. A. Kozlovskiy, V. N. Kotlyar, M. I. Kalganov, I. I. Belov, A. I. Tugarinov, N. P. Chunarev, B. V. Polovinkin, V. A. Kitayev, N. I. Gemodanov, and others) and State prizes for outstanding contributions in the discovery of numerous deposits and their exploitation and also for major contributions to science and practical work.

There is no region of mining geological work in the country where the famous graduates of MGRI cannot be found, helping to build the bright communist future with their selfless labor. The institute is proud of its graduates academicians V. I. Smirnov, F. V. Chukhrov,

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F. V. Chukhrov, A. V. Peyve, I. S. Iovchev (Bulgaria), Kh. M. Abdulayev, G. V. Bogomolov, and U. F. Akhmedsafin, as well as corresponding members of the Academy of Sciences USSR and the academies of the Union republics P. N. Kropotkin, A. P. Lisitsyn, V. A. Zharikov, V. L. Barsukov, I. V. Luchitskiy, G. I. Gorbunov, L. V. Tauson, Ye. F. Savarenskiy, P. F. Shvetsov, F. K. Shipulin, A. I. Tugarinov, F. T. Kashirin, K. Ye. Kaymurzayev, and K. Ya. Springis.

In its 60 years the institute has originated and shaped independent geological exploration and mining science schools that have trained 208 doctors of sciences and 1,438 candidates of sciences, many of whom today head scientific research institutes, higher educational institutions, departments, and scientific laboratories at production enterprises and perform important work in the ministries of geology and nonferrous metallurgy and the administrative apparatus of USSR Gosplan and the USSR Council of Ministers.

The last decade has been very fruitful in a scientific sense. Teachers V. I. Chernov, D. S. Dayev, I. I. Vishnevskaya, V. A. Simakov, Ye. Ya. Basin, I. K. Gavich, V. Ye. Boytsov, T. M. Kaykova, V. M. Tseysler, L. G. Grabchak, L. Z. Bobrovnikov, V. V. Alekseyev, N. N. Solov'yev, A. A. Nikitin, A. D. Frolov, and P. P. Makagonov successfully defended their doctoral dissertations. In its 60 years the institute has trained more than 200 doctors and candidates of sciences for the socialist and developing countries.

The Moscow Order of the Red Banner Geological Exploration Institute imeni Sergo Ordzhonikidze now has four daytime departments and an evening department in which 3,703 undergraduate students, including 146 from 31 different countries in Europe, Asia, Africa, and Latin America, as well as more than 300 graduate students, practical trainees, graduate examinees, and competitive researchers, are studying in seven specializations (0101, 0105, 0107, 0108, 0202, 0213, and 1705). The institute also has a preparatory division with 100 students.

All the academic and scientific work as well as the multifaceted task of communist indoctrination of the student body is organized by 33 subdepartments. Three of them were formed in the last decade ("Geotechnology of Ores of Rare and Radioactive Metals," "Engineering Cybernetics," and "Working Placer Deposits") and two were formed from the subdepartment of general geophysical methods ("Seismic and Well Methods of Exploration" and "Electrical, Gravitational, and Magnetic Methods of Exploration"). The social science subdepartments "History of the CPSU" (Professor S. P. Lyushin), "Political Economy" (Professor G. S. Shcherbakov) and "Philosophy and Scientific Communism" (docent M. N. Filatov) have become strong, independent units at the school. The institute now has a very highly qualified staff of 334 professors and teachers, 76 percent of whom have academic titles and degrees including two corresponding members of the Academy of Sciences USSR (M. V. Muratov and M. I. Agoshkov), 64 professor-doctors of sciences, and 189 docents and candidates of sciences. At the same time

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academicians, prominent scientists, important ministry officials, and production innovators are also brought in to give lectures.

The fundamental theoretical and technical rearmament of the entire national geological service that is taking place, scientific-technical progress in the mining industry, the considerable attention given to questions of rational use of natural resources at the 25th CPSU Congress in the document "Primary Directions of Development of the USSR National Economy for 1976-1980," the words of Comrade L. I. Brezhnev at this congress concerning the necessity of helping nature disclose its vital strength more fully, and the "Fundamentals of Legislation of the USSR and Union Republics Concerning the Earth's Interior" (put into effect on 1 January 1976) have provided the methodological foundation at our institute for further improvement of the educational and scientific process, expansion of material-technical facilities, and communist indoctrination of the future commanders of production and young scientists. Through the collective, creative effort of all teachers, development of documents for scientific substantiation of the educational process was completed in 1970, approved by the board of directors of the RSFSR Ministry of Higher and Secondary Specialized Education, and recommended for all higher educational institutions of the Russian Federation as one of the important ways to improve the educational process. New individual (for MGRI) and model (for all other mining geological higher educational institutions) curricula and logic diagrams to give students organized economic knowledge and continuous mathematical training were developed on the basis of scientific substantiation of the educational process. Leading professors at the institute, commissioned by the USSR Ministry of Higher Secondary Specialized Education, developed syllabi for the geological specializations in our country and similar institutions in the socialist countries. The labor-intensive job of compiling technological charts of all the training courses being given in the institute is now being completed.

The last decade has seen a significant expansion in the training of specialists in the latest areas of science and technology, where need is determined by the sectorial ministries and departments (this need includes the enterprises of Moscow city and Moscow Oblast). Beginning in the third or fourth year of study specialists (up to 100 persons) are trained on the basis of individual curricula in geotechnology, exploration and exploitation of deposits of crystal raw materials, engineering geological testing for construction of unique structures, the geology and exploration of deposits of rare metals, the economics of labor, the geology and exploration of deposits of precious and semiprecious stones, appraisal and working of precious and semiprecious stones. The educational laboratory facilities of virtually all subdepartments at the institute have been modernized. New laboratories for aerial techniques in geology, electron microscopy, the geology and geochemistry of rare and radioactive elements, technological ore analysis, geotechnology, and other fields have been opened. The subdepartment of mathematics has set up and successfully operates a computer laboratory equipped with Odra-1204, Nairi, and Promin'

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computers and a classroom with small keyboard computers. Intensive preparations are underway to incorporate modern new computers in the new subdepartment of "Engineering Cybernetics." The audiovisual rooms of the subdepartments of foreign languages and Russian and the teaching methods office on techniques of exploration of mineral deposit (a prize-winner at the Exhibition of the Achievements of the National Economy), mechanics, economics, and diploma projects are having a significant, positive effect in developing and improving conditions for independent work by students. Since 1976 21 subdepartmental offices at the Rudoznatsy Student House have begun educational consultation work.

The ore-mineralogy and geology-paleontology museums of the institute with their rich, unique collections have begun to be used much more in student academic and scientific work and also to meet the steadily growing needs of numerous scientific organizations, tekhnikums, and Moscow schools with respect to excursions, consultations, and making duplicate collections.

A technical teaching aids office was opened recently and has had a positive effect by supplying subdepartments with film and slide projectors, tape recorders, amplifiers, and Ogonek monitoring units. The subdepartment of geodesy and mine surveying (Professor V. I. Borshch-Kompaniyets) has a new 30-seat classroom equipped with a Ritm-2 unit. The card file at the technical aids office contains 231 educational films, 820 film strips, and more than 15,000 slides. At the present time up to 20 percent of all types of classes use technical aids. As an experiment, the subdepartment of chemistry is training students according to a programmed system.

In 1973-74 a good deal of methodological and organizational work was done on the presentation of new courses such as introduction to the specialization, environmental protection, Soviet law, computer technology in engineering and economic calculations, and the cycle of organizational and economic disciplines. Since 1976 academic research projects have been introduced in all the curricula of upper division students. The planning and monitoring of independent work by students have improved significantly thanks to monthly testing in all disciplines which was instituted in 1972.

An exceptionally important place in the many different types of extra-curricular work with students belongs to writing research papers under the direction of the social science subdepartments. In recent years 100 percent of the students have participated in writing research papers on sociopolitical themes, with 65 percent of them given at seminars and theoretical conferences or used in speeches to the young people of Moscow enterprises and in talks with workers at on-the-job training sites. The sociopolitical section has become a necessary part of practical training. These forms of independent work by students, as well as their active participation in the sections of the department of public occupations, promote the sociopolitical development of young specialists and help them prepare to take the state examination in scientific communism that was introduced in 1976.

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The multifaceted teaching methods work done at the institute is organized and carried on by eight permanently operative methods commissions headed by experienced professors (A. I. Kravtsov, I. K. Gavich, A. O. Vercheba, A. Ye. Mikhaylov, G. Ts. Tumarkin, B. M. Rebrik, L. Z. Bobrovnikov, and V. G. Semenov) and by the Council of Teachers of the social science subdepartments.

Graduates of MGRI have always stood out for good practical training received during the period of class, production, and pre-diploma practical training. In recent years this trend has grown stronger and the academic-scientific facilities and practical training techniques have continued to be improved at the Zagorsk and Crimean training sites on the basis of using the latest equipment and computers, aggregating the problems being solved, and introducing practice research elements in them. Under conditions close to real production students master the practical skills of work with various modern drilling tools and mining machines, the use of geophysical equipment and nuclear radiometric instruments, and the procedures of hydrogeological and engineering geological prospecting and blasting work. Significantly more students do their production and pre-diploma practice training in expeditions and parties of the scientific research sector and conduct studies of very timely national economic problems. The formation of practice scientific detachments of up to 200 students for the period of winter vacation, organized by the scientific research sector and department of physical training, proved exceptionally effective.

The professors and teachers at MGRI have published more than 723 textbooks, aids, and scientific monographs used by students in mining geological specializations at all the higher educational institutions of the country and many foreign schools. In just the last 10 years college libraries have received more than 100 new and valuable textbooks, aids, and monographs. Among these works have been: "Atlas of Paleotectonic and Structural-Formation Maps of the Southwestern Altay" and "Historical Geology" by a collective of authors under the direction of corresponding member of the Academy of Sciences USSR M. V. Muratov; "Geology of the USSR, Volume 8, The Crimea, Mineral Products" by M. V. Muratov; "Structural Geology and Geological Mapping" by A. Ye. Mikhaylov; "Short Course in Paleontology" by a collective of authors under the direction of G. I. Nemkov; "Introduction to Tectonic Analysis of Sedimentary Geological Formations" by V. M. Tseysler; "Practical Handbook of Mineralogy" by N. A. Smol'yaninov; "Diagnostic Properties of Ore Minerals" by S. A. Yushko; "Structure of Ore Fields and Deposits" by P. D. Yakovlev and F. I. Vol'fson; "Deposits of Mineral Fuels" by A. I. Kravtsov and N. I. Pogrebnov; "Mine Geology" by A. I. Kravtsov and A. A. Trofimov; "Deposits of Radioactive and Rare Metals" by a collective of authors under the direction of V. N. Kotlyar and N. I. Yegorov; "Deposits of Uranium and Rare Metals" by I. M. Bayushkin and N. N. Zheleznyak; "The Geology and Methods of Prospecting for Uranium Deposits" by A. B. Kazhdan, V. Ye. Boytsov, and D. F. Zimin; "Methodological Foundations of Exploration of Mineral Products" and "Exploration of Mineral Deposits" by A. B. Kazhdan; "Seismic Exploration" by I. I. Gurvich;

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"Electrical Exploration" by Yu. V. Yakubovskiy; "Underground Geophysics" and "Combining Geophysical Techniques in Solving Geological Problems" by a collective of authors under the direction of A. G. Tarkhov; "Geophysical Methods of Studying Ore-Bearing Structures" by V. V. Brodovoy; "Radiometry and Nuclear Geophysics" by a collective of authors under the direction of L. V. Gorbushina; "Isotopes of Radon and Products of Their Decay in Nature" by A. S. Serdyukova and Yu. T. Kapitanov; "Water Resources of the USSR, Their Use and Protection" by G. P. Sinyagin; "Dynamics of Subterranean Waters" by P. P. Klimentov and V. M. Kononov; "General Hydrogeology" by G. Ya. Bogdanov and P. P. Klimentov; "Practical Hydrometry" by A. A. Luchsheva; "Methodological Handbook of Data Processing in Engineering Geological Studies" by I. S. Komarova; "Texture and Deformation of Clay Rocks" by G. K. Bondarik; "Exploratory Drilling" by N. I. Kulichikhin and B. I. Vozdvizhenskiy; "Current Drilling Procedures" by B. I. Vozdvizhenskiy; "Percussion Drilling of Grounds" by B. M. Rebrik; "Mining" by S. A. Brylov; "Hydraulic Mechanization of Geological Exploration and Mining Work" by D. P. Lobanov and A. Ye. Smoldyrev; "Transport Machines and Complexes of Mining Enterprises" by N. V. Tikhonov; "Radioengineering and Electronics" by L. Z. Bobrovnikov; "Electrical Equipment and Electrical Supply for Geological Exploration Work" by A. M. Limitovskiy; "Technology and Full Mechanization of Exploitation of Placer Deposits" by S. M. Shorokhov; "Exploitation of Deposits of Radioactive Ores" by G. N. Popov and D. P. Lobanov; "Open-Cut Exploitation of Intricately Structured Deposits of Nonferrous Metals" by a collective of authors under the direction of B. P. Yumatov; "Constructing and Rebuilding Mining Pits" by B. P. Yumatov and Zh. V. Bunin; "Technical-Economic Evaluation of Extraction of Minerals from Underground" by a collective of authors under the direction of corresponding member of the Academy of Sciences of the USSR M. I. Agoshkov; "The Economics of Mineral Raw Materials and Geological Exploration Work" by G. P. Sinyagin; "The Economics of Geological Exploration Work" by L. P. Kobakhidze; "The Economics of the Mining Industry in Planning Geological Exploration Work" by M. I. Agoshkov; "Financing Geological Exploration Work" by A. D. Garber; "Environmental Protection in the Exploration and Exploitation of Mineral Products" by a collective of authors under the direction of S. A. Brylov.

Many textbooks have already gone through two or three editions. The textbooks and aids of professors G. N. Popov, I. I. Gurvich, N. I. Yegorov, P. P. Klimentov, B. I. Vozdvizhenskiy, V. S. Vladislavlev, and M. I. Plyusnin have been translated into English, Polish, and Vietnamese and have become standard references for students in many foreign countries.

Very valuable learning aids, methodological instructions, and laboratory outlines have been written for all special subjects and published within the institution. Among the authors are I. F. Grigor'yev, M. P. Isayenko, I. F. Tursova, V. A. Simakov, T. M. Kaykova, V. P. Nebera, I. K. Gavich, G. Ts. Tumarkin, D. S. Dayev, V. I. Chernov, I. F. Romanovich, N. V. Demin, L. I. Lunev, P. V. Polezhayev, V. I. Borisovich, A. A. Mautina, Ye. A. Uspenskaya, and many other professors and teachers.

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The institute operates a department for raising the qualifications of executives of the USSR Ministry of Geology with an annual student body of 700. Teachers from many higher educational institutions in the USSR and socialist countries and stipend students of the United Nations go through on-the-job training at the institute. In recent years the institute has conducted classes in a science-practical school for specialists from Bulgaria, East Germany, and Czechoslovakia on timely questions of the geology of rare metal raw materials. The close combination of academic and scientific work is very important in indoctrination of the students. The institute has broad possibilities for this thanks to the vigorous scientific research of the teachers aimed at accelerating scientific-technical progress in the country's geological exploration service and in mining.

The Moscow Geological Exploration Institute is continuing the glorious traditions of the MGA in maintaining close communication with production, scientific establishments of the Academy of Sciences USSR, and sectorial scientific research institutes. More than 100 contracts for creative cooperation provide mutual enrichment for project participants and open up new opportunities.

In the last 10 years the volume of scientific research on economic contracts has increased steadily and is now about 4.3 million rubles a year with an economic benefit of about five rubles per ruble of expenditures from introduction of completed studies.

The scientists working at the institute are marking its 60th anniversary with a significant contribution to development of the primary branches of geological science and geological exploration and solving the problems of comprehensive extraction of ores of nonferrous, rare, and radioactive metals from the earth's interior, rational use of all mineral raw material resources, and preservation of the natural environment, matters of deep concern to world society today. And in this important state work MGRI is carefully maintaining, as a special asset, the scientific schools of its outstanding predecessors and developing them through the efforts of young and talented students who thoroughly understand the rules of the creative processes of our mighty socialist society.

Corresponding member of the Academy of Sciences USSR and twice winner of the USSR State Prize M. V. Muratov and his colleagues professors A. Ye. Mikhaylov, V. N. Pavlinov, G. I. Nemkov, V. M. Tseysler, and E. Ya. Leven are devoting their creative labor to studying the geological structure of particular regions of the USSR. The efforts of professors Ye. Ye. Zakharov, V. N. Kotlyar, V. Ye. Boytsov, T. M. Kaykova, V. M. Grigor'yev, and M. P. Isayenko are directed to identifying the rules that govern the location of useful deposits of ferrous, nonferrous, rare, and radioactive elements. Professors I. F. Grigor'yev, P. V. Kalinin, D. A. Mineyev, N. I. Yegorov, B. M. Ronenson, and S. A. Yushko represent the school of mineralogists, while professors I. F. Trusova, V. I. Chernov, I. I. Vishnevskaya,

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and S. V. Tikhomirov are the school of petrographers and lithologists. Professors A. B. Kazhdan, V. V. Aristov, D. A. Zenkov, and N. N. Solov'yev are working fruitfully on the problems of techniques of prospecting for and exploring deposits of mineral products. Professor A. I. Kravstov heads the scientific school in the field of the geology and geochemistry of the natural gases of coal, ore, and nonore deposits of mineral products. Professors V. M. Shvets, P. P. Klimentov, I. K. Gavich, G. Ts. Tumarkin, I. S. Komarov, G. K. Bondarik, and G. S. Vartan'yan are studying the problems of hydrogeology, hydrochemistry, and engineering geology. Professors D. S. Dayev, M. I. Plyusnin, I. I. Gurvich, Yu. V. Yakubovskiy, L. Z. Bobrovnikov, V. G. Semenov, A. D. Frolov, A. A. Nikitin, F. M. Kamenetskiy, and P. P. Makagonov are successfully working out the theoretical foundations and new techniques of geophysical prospecting and exploration of useful minerals.

The studies of professors B. I. Vozdvizhenskiy, D. N. Bashkatov, V. S. Vladislavlev, S. A. Volkov, and B. M. Rebrik to improve the equipment and technology of drilling geological exploration wells for various purposes occupy a large place in the institute's range of scientific subjects. The works of professor Ye. A. Kozlovskiy's scientific school on optimization and automation of exploratory drilling based on broad use of computers, the advances of modern electrical engineering, and application of economic efficiency criteria has reached a qualitatively new level.

Professors S. A. Brylov, L. G. Grabchak, A. O. Vercheba, N. V. Tikhonov, and V. V. Alekseyev are making a significant contribution to the equipment and technology for conducting geological exploration excavations, mechanization and automation of mining geological processes, and environmental protection. In their works professors B. P. Yumatov, V. A. Simakov, S. M. Shorokhov, and S. V. Potemkin are working out the problematic issues of extracting ores of rare metals and placer deposits. In recent years a new and promising field of knowledge and production, geotechnology, has developed at the institute. Professors D. P. Lobanov, V. P. Nebera, V. Zh. Arens, and a large group of young scientists are working in this field. For more than 10 years Professor A. Ye. Smoldyrev has successfully directed work on problems of technique and equipment for prospecting, exploration, and economic appraisal of coastal and offshore placer deposits of minerals. Under the direction of corresponding member of the Academy of Sciences USSR and winner of the USSR State Prize M. I. Agoshkov, professors G. P. Sinyagin, L. P. Kobakhidze, and G. S. Shcherbakov and their students have undertaken important studies in the fields of the economics of mineral raw material and the scientific organization and planning of geological exploration and mining production in light of current trends in the scientific-technical revolution.

The creative aspirations of these scientific schools are directed to carrying out the plans of scientific research and experimental design work of the ministries of Geology, Nonferrous Metallurgy, Ferrous

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Metallurgy, Medium Machine Building, the Coal Industry, the Construction Materials Industry, Land Reclamation and Water Resources, and various other ministries and departments of the USSR. In many scientific problems of the State Committee for Science and Technology of the USSR Council of Ministers and Presidium of the Academy of Sciences USSR, for example "Scientific Foundations of Improvement of the Environment and Rational Use of Natural Resources," "Cryology of the Earth," and "New Processes and Techniques of Productive Work in Mining," MGRI scientists are among the active participants. Institute associates are also making a scientific contribution to work on the comprehensive scientific program of the RSFSR Ministry of Higher and Secondary Specialized Education entitled "Protection and Use of the Earth's Interior," while in the "World Ocean" program MGRI is the head organization and scientists from six subdepartments participate.

The institute's five sectorial scientific research laboratories are working on important problems today: "The Geology and Geochemistry of Gases from the Coal Basins and Deposits of the USSR"; "The Geology and Geochemistry of Natural Gases and Gas-Geochemical Methods of Prospecting for Ore Deposits"; "Technology of Exploratory Drilling"; "Investigation of Mineral Raw Material for Industry, Building Materials, and Techniques of Operations Exploration"; "Geothermal Methods of Prospecting for and Exploring Deposits of Mineral Products." Among the important scientific and practical results of the work of the scientists have been: development of new methods of predicting gas presence in coal and ore deposits and prospecting for intrusive bodies containing ore formations and mineral waters; new methods of mapping faulted structures (scientific leader A. I. Kravtsov; this group of projects was awarded the Diploma 1st Degree of the Exhibition of Achievements of the National Economy and its authors were given gold and silver medals); increasing the average rate of drilling by 69 percent, reducing diamond usage in drilling by 73 percent, and increasing the strength of bits by 117 percent (scientific director D. N. Bashkatov); devising new methods of geological mapping of deposits of non-ore mineral products, identifying prospecting criteria and making prognosis maps for deposits of phlogopite and asbestos (scientific director I. F. Romanovich).

The compiling of a geological map of the northern part of the Il'men Mountains and the Nadezhinskaya group of deposits, which made it possible to add significantly to knowledge of the geology of this part of the region and open up a new industrial deposit of high-quality phlogopite with an economic impact of 1.0 million rubles, mark the end of a long-term scientific project under the direction of B. M. Ronenson. The pure research to learn the rules governing the location of deposits in volcanic formations done by Professor V. N. Kotlyar was awarded the Lenin Prize of the USSR. The long-term, persistent efforts of scientists of the institute led by V. N. Pavlinov were crowned by discovery of the Gol'tsovskoye deposit in Eastern Siberia. Honored geologists of the RSFSR V. N. Pavlinov now carries the honorary title of discoverer of this deposit.

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The vast project directed by Professor A. Ye. Mikhaylov to compile a geological map of the useful minerals of Kounradskiy Rayon in Central Kazakhstan for an area of 12,000 square kilometers has identified the principal industrial types of ore, devised a metallogenic zoning system, and discovered seven sectors that show promise with respect to ore. This same collective's study of the Upper Jurassic reef complexes of the Southwestern Gissar enabled them to identify zones where reef-type natural gas traps have developed, thereby increasing reserves of this valuable raw material by 20 billion cubic meters and providing an economic impact of 3.6 million rubles for the Urtaulak deposit alone.

The institute's increasingly active participation in development of deposits in the Baikal-Amur Mainline zone enabled the scientists led by K. M. Mel'nikova to identify for the first time mineral groups of several metals in the Udokan ore field region on the basis of geological maps. The quantitative-qualitative criteria of the degree of exploration of deposits developed under the scientific direction of A. B. Kazhdan made it possible to greatly improve the reliability of estimates of explored reserves and to perform economic evaluations of geological exploration work.

The All-Union Mineralogical Society and International Commission on New Minerals have given the aktiv of young institute scientists Ye. N. Zav'yalov, V. D. Begizov, and Ye. G. Pavlov credit for discovering the new minerals "palladoarsenide," "rakligite," "aleskskite," "maslovite," "palarstanide," while a Diploma of the All-Union Mineralogical Society was received for the mineral "taymyrite."

Scientists from the institute under the scientific direction of P. P. Klimentov were able to help solve the problem of water supply to the Vorkuta industrial region by tapping underground waters. Fundamentally new techniques of probabilistic statistical processing of hydrochemical data were developed and automated systems created to process hydrogeological information and algorithms for manipulating files within the system (professors G. Ts. Tumarkin and I. K. Gavich). The first comprehensive methodology for choosing the optimal version of operation of vertical drainage based on the use of analog and digital computers was devised for the conditions of the submontane plain of the Kabardino-Balkar ASSR (in connection with an expansion of the irrigation systems there).

The scientific school of geophysicists at the institute, of which F. M. Kamenetskiy is scientific director, has developed a new method of aerial electrical reconnaissance for mineral deposits and introduced in practical geological exploration work a multichannel geophysical instrument with a digital data recording system placed in a KA-26 helicopter. A new method of statistical analysis of the parameters of seismic profiling by the reflected wave technique (scientific director I. I. Gurvich) made it possible to significantly improve the reliability of interpretation of field materials and draw additional, valuable information from them. The portable wave electromagnetic logging unit developed under the scientific direction of D. S. Dayev

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made possible a great improvement in the methodology of this type of well logging.

The Committee for Inventions and Discoveries of the USSR Council of Ministers registered the scientific discovery "The Phenomenon of Change in the Chemical Composition of Subterranean Waters During Earthquakes" by diploma No 129 of 1 March 1971, which was the result of long years of scientific research by L. V. Gorbushina, a docent at the institute.

Under the scientific direction of S. A. Brylov an ultrasonic method and equipment for determining the locales of crystal-bearing cavities were developed and introduced. A drilling rig for drilling large-diameter wells for various purposes was built under the scientific direction of L. G. Grabchak and is being successfully used in construction of the Baikal-Amur Mainline. A groove-transport aggregate (scientific director N. V. Tikhonov) for working thick layers of sandy-argillaceous ores occurring in complex mining geological conditions was built. A. A. Smolyanitskiy's subdepartment is working hard searching for and developing the fundamentals of the pulsed discharge method of doing mine exploration and to build new technical equipment.

The work of the scientists under the scientific direction of D. N. Bashkatov has been devoted to industrial application of small diamonds in drill bits, working out the technology of securing wells against water and technical means for protection of subterranean waters, and optimizing the processes of drilling horizontal and slightly inclined, very long wells. Under the direction of G. N. Popov drill-screw conveyor systems of excavating valuable ores from gently inclined layers and a two-stage system of mining with rubbish at the Irtysh Mine were developed and introduced. The ideas in scientific deductions of V. A. Simakov made possible new solutions to the problem of impoverishment of ores during processing. Introduction of the technological scheme devised according to this method at the Khrustal'noye Mining and Concentrating Combine permitted an economic benefit of 600,000 rubles.

The scientific research conducted under the direction of B. P. Yumatov made possible a series of improvements in the technology of ore extraction at the Noril'sk, Sorsk, Tyrnyauz, and Agarak open-cut mines. Studies of deep stripping of peat in drag-type mines, highly efficient technology for stripping in swampy terrain, protection of the natural environment in working placer deposits, and equipment and technology for extracting fine gold done by scientists under the direction of S. M. Shorokhov have been extremely helpful to enterprises of nonferrous metallurgy.

The group of young scientists in the geotechnology subdepartment has done productive work (under the direction of D. P. Lobanov) on theoretical substantiation, experimental design development, and bench testing of gas-thermodynamic pulsed-percussion devices with a high-energy unitary blow to be used for various purposes in mining geology and other sectors. Theoretical research, experimental industrial testing, and introduction of fundamentally new methods of working

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deposits by the hydraulic well method and by underground and heap leaching are going forward on a broad scale. In just the five years 1972-1977 the economic benefit from introducing methods of underground leaching of metal from ores at research sites of this subdepartment was 18.2 million rubles.

The 10-year activities of the collective of scientists directed by A. Ye. Smoldyrev to devise a set of methods and equipment for geological study of the upper parts of the cross-section in the shelf areas of non-Arctic seas proved very productive. Working in cooperation with the Pacific Ocean Marine Geological Exploration Expedition and the Primorskiy TGU [expansion unknown], they first wrote and adopted a prognosis map with a set of auxiliary maps. All geological methods research work and sampling of bottom deposits was completed with development and publication of methodological recommendations and construction of mock-ups and models of devices and equipment to be turned over to production organizations.

The primary efforts of the economic scientists under the direction of corresponding member of the Academy of Sciences USSR M. I. Agoshkev were devoted to the development and introduction of the scientific foundations of evaluating the economic efficiency of geological exploration and mining work into practice at geological exploration and mining enterprises. As part of the general program for rational use of the earth's interior and environmental protection the research of MGRI economic scientists was a significant contribution to the economic science and practice of developing our country's mineral raw material base.

The higher scientific-technical level and quality of scientific research are characterized by the increase in the number of scientific research projects done at the level of inventions and by the submission of up to 4.27 invention applications per 100,000 rubles worth of defensible subjects and receiving up to 2.32 positive decisions on them. In just the last 10 years associates of the institute have received 315 author's certificates for inventions, diplomas for discoveries, patents, and medals of the Exhibition of the Achievements of the National Economy. Some of the inventions have been patented in the United States, Canada, France, Sweden, Syria, India, and Pakistan.

Students of the institute are consistent and active participants (90 percent) in scientific research. They conduct their research as members of expeditions, scientific study groups in the subdepartments, and in the student research laboratory. They carry on practice research in the scientific laboratories of both their own and the sectorial institutes of the city of Moscow. There were numerous students among the 130 active inventors at the institute in 1978. Students also write articles in the scientific journals. Each year young researchers win medals of the Exhibition of the Achievements of the National Economy, diplomas, and certificates in science competitions. In 1977 the Presidium of the Academy of Sciences USSR awarded the

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Medal of the Academy of Sciences USSR and a prize to MGRI students R. I. Nedumov, T. S. Rossovsckaya, L. P. Aksenova, and T. S. Postnikova for their study "The Effectiveness of Statistical Estimates of Geological Exploration Parameters from Small Samples," done under the direction of O. I. Gus'kov.

All the students of MGRI, including the foreign students, take an active part in all-Union student competitions on timely problems of the social sciences, history of the Komsomol, and international youth movement, and the best projects receive honorary awards. The Moscow city student Olympics in mathematics, civics, chemistry, foreign languages, and economics are becoming increasingly popular among students. Considerable importance is attached to all these and other forms of developing the creative activism of students at MGRI. In recent years students have begun to attend a class in patent affairs and to enjoy the services of the institute's patent division and published methodological guides on patents and licenses.

The steadily growing scientific potential and reputation of MGRI enable it to perform increasingly important and respectable assignments from the ministry. It is 10 years already that the Head Council on Geology and Exploration of Mineral Products of the RSFSR Ministry of Higher and Specialized Education (chairman D. P. Lobanov, learned secretary docent I. N. Kadyrov), which takes in 45 higher educational institutions in the Russian Federation, has been based at MGRI. The council has 29 leading specialists in the field of geology, and 16 of them are active scientists at MGRI (professors V. V. Aristov, Yu. V. Yakubovskiy, V. Ye. Boytsov, A. I. Kravtsov, A. Ye. Mikhaylov, S. V. Tikhomirov, I. S. Komarov, D. N. Bashkatov, V. M. Grigor'yev, I. F. Romanovich, V. M. Tseysler, V. M. Shvets, and S. A. Brylov and docent V. V. Brodovoy). The council is making its contribution to solving the problem of improving teaching methods work, coordinating scientific research projects for all specializations in geological science, and planning the publication of literature within the educational institutions.

Since 1974 the Head Council on Political Economy of the RSFSR Ministry of Higher and Secondary Specialized Education has been based at MGRI (Council chairman professor N. D. Kolesov, deputy chairman professor G. S. Shcherbakov, learned secretary docent V. P. Khalturina). The council coordinates the research of political economists at higher educational institutions of the RSFSR in the areas of problems of the economics of a developed socialist society, evolving more efficient forms and methods of developing the productive forces of Siberia and the Far East, the socialist way of life, joining the scientific-technical revolution with the advantages of socialism as a key path of accelerated social development on the way to communism, the economic mechanism of a socialist society, the development of socialist integration, and new phenomena in present-day capitalism.

In 1975 MGRI became the base of activities for the RSFSR Ministry of Higher and Secondary Specialized Education's problem council "Party Management of State and Public Organizations under Conditions of

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Developed Socialism" (chairman of the Council — honored scientist of the RSFSR professor B. M. Morozov, deputy chairman professor S. P. Lyushin, and learned secretary docent I. L. Reshin). The council influences 83 subdepartments of CPSU history and more than 250 researchers at higher educational institutions in the Russian Federation and has a beneficial effect on all facets of improving teaching methods and socio-political life in the collectives of the schools.

By decision of the Higher Degree Commission of the USSR Council of Ministers, MGRI has 12 specialized councils for the defense of candidate (5) and doctoral (7) dissertations in the fields of the geological-mineralogical, technical, physico-mathematical, and economic sciences.

In 1977 the Interschool Foreign Language Laboratory was transferred by order of the RSFSR Ministry of Higher and Secondary Specialized Education from the Moscow Automatic Machine Institute to MGRI where scientific direction is exercised by the head of the subdepartment, docent P. V. Naumenkov. The primary assignment of this laboratory is to develop and introduce contemporary methods of teaching students foreign languages at non-language higher educational institutions of the Russian Federation. The vigorous work of these councils and the foreign language laboratory and creative use of the results of their activities offer the collective of the institute enormous opportunities to improve the entire educational and indoctrinational process.

Carrying out the behests of Vladimir Il'ich Lenin on the international obligations of the world's first Land of Soviets the collective of MGRI has broadened and deepened educational-scientific and cultural ties with foreign higher educational institutions.

Our relations with the Sofia Mining Geological Institute in Bulgaria, the Freiberg Mining Academy in East Germany, and the Krakow Mining and Metallurgical Academy in Poland are developing and growing stronger on the basis of long-term treaties of friendship and cooperation. In just the last 10 years more than 500 students from the Soviet Union and from these partner countries under the direction of almost 100 teachers have gone through familiarization production training at installations in the Soviet Union, Bulgaria, East Germany, and Poland. The curricula and syllabi for related specializations at our higher educational institutions have been made much more similar and the exchange of students for full courses of study and teachers to give lectures, perform scientific research work, and take part in scientific conferences has increased.

New forms of scientific ties have developed and reached a qualitatively higher level. Scientific research is now done by entire collectives of subdepartments for scientific problems of great economic importance to both countries. For example, comparative study of the geological structure of the western part of the Crimean Peninsula and the eastern part of Northern Bulgaria (also encompassing the water of the Black Sea between them) made it possible for the first time to compile 34 paleofacies maps on a scale of 1:1,000,000 for all the primary subdivisions of the Mesozoic and Cenozoic. The first geological overview of the pre-Mesozoic erosion section was produced for the Black Sea area and

43
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adjacent regions. For the first time the geological structure and tectonics of territories covered by water were depicted on tectonic and neotectonic maps. This work by Soviet (M. V. Muratov and A. Ye. Mikhaylov) and Bulgarian (T. B. Dobrev, S. I. Zafirov, and S. B. Strashchimirov) scientists was highly praised at the USSR Ministry of Geology and the Bulgarian Ministry of Mineral Resources. Four other scientific research projects by collectives of scientists from MGRI and VMGI [expansion unknown] have been performed and are continuing on the same organizational and methodological plane.

Three scientific problems are being developed jointly with scientists from the Freiberg Mining Academy. These problems encompass the questions of devising new technology for working deposits with complex mining geological conditions; analyzing underground cavities by the emanation method; improving geophysical methods of prospecting for and exploring mineral products.

Joint work with scientists from the Krakow Mining and Metallurgical Academy centers on three important problems: geochemistry of the natural gases of the coal deposits of the Donets (USSR) and Upper Silesian (Poland) basins; improving the processes of dust suppression during mining work; devising flow technology for open pits with continuous-action equipment.

The prolonged scientific cooperation between professors K. Woinar of the Krakow Academy and V. S. Vladislavlev of MGRI enabled them to write, and publish in Polish, the basic textbook "Drilling." A monograph entitled "Engineering Geological Studies for Hydroengineering Construction" by a collective of authors including professor I. S. Komarov (MGRI), engineer A. A. Molokov (USSR All-Union Planning, Surveying, and Research Institute imeni S. Ya. Zhuk), professor F. Reuter (Freiberg Mining Academy), and professor Ja. Dzewanski (Krakow Academy) is being prepared for publication in 1980.

The Moscow Geological Exploration Institute has maintained close relations with the Socialist Republic of Vietnam since 1955. During this time 173 young Vietnamese men and women have received MGRI diplomas of higher geological exploration education; 24 of them have defended candidate's dissertations and one defended a doctoral dissertation. The dissertation subjects were timely problems of development of mineral raw materials, land reclamation, water supply, and hydroconstruction in Vietnam. Scientists from MGRI such as P. P. Klimentov, G. I. Nemkov, I. K. Gavich, I. S. Komarov, V. I. Drozdov, and L. A. Yarg, among others, provide regular scientific methods help to specialists from this country.

On 5 May 1978 Comrade Nguyen Huy Khieu, Extraordinary and Official Ambassador, awarded the Order of Friendship of the Socialist Republic of Vietnam to MGRI for help given to the Government of Vietnam in training scientific and technical specialists.

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MGRI gives many types of sponsorship help to the Conakry Polytechnic Institute of the Guinea People's Revolutionary Republic. Teachers from the Moscow Geological Exploration Institute imeni S. Ordzhonikidze have done the basic methodological-organizational and educational work in the mining geology department of this institute (in the city of Bake) steadily for 14 years now.

For 10 years we have cooperated with the Osman University in the city of Hyderabad, India within the framework of the long-term agreement between the USSR Ministry of Higher and Secondary Specialized Education and the University Commission of the Ministry of Education of India. In this relatively short time a geophysical department and the center of exploration geophysics in India have been set up at Osman University with the active participation of our professors (M. I. Plyusnin, A. G. Tarkhov, F. M. Kamenetskiy, I. I. Gurvich, and docents V. M. Bondarenko, G. A. Solov'yev, Ye. I. Savenko, F. T. Borisovich, G. N. Baganik, and others). The laboratory of this unique educational and science center has up-to-date geophysical apparatus and equipment delivered by the USSR with our assistance. The department has a full complement of national teachers who went through on-the-job training at MGRI. Indian (professors Bhimasankaram, Shashachari, and Matur) and Soviet (professors I. I. Gurvich and M. I. Plyusnin and docents G. A. Solov'yev and Ye. I. Savenko) together have published the textbooks "Introduction to Field Theory," "Radiometry," "Seismic Exploration," and "Geophysical Well Testing" and more than 15 teaching aids in English. About 110 Indian citizens who went through courses of study with curricula resembling ours have successfully completed studies and received diplomas as engineer-geophysicists. Twelve candidate's dissertations have been prepared in the department and Viji Ragava defended a candidate's dissertation at our institute. In the coming years a large program of cooperation between MGRI and the geophysical department of Osman University is planned.

About 90 foreign teachers and scientific associates have gone through on-the-job training in the subdepartments of MGRI. More than 70 of the most highly trained pedagogs at MGRI have been sent for different periods of time to give lectures at higher educational institutions in Cuba, Czechoslovakia, Yugoslavia, Afghanistan, Laos, Vietnam, Algeria, Syria, Angola, Congo, India, Guinea, and the United States.

The scientists from MGRI have taken an active part in the work of international scientific conferences and geological and mining congresses and symposia held in Hungary, Bulgaria, East Germany, Italy, England, the United States, Canada, West Germany, Brazil, and other countries. The institute has sent its leading specialists to provide technical aid at mining and geological installations in Mongolia, Bulgaria, East Germany, Czechoslovakia, Peru, Iran, Madagascar, India, and Syria.

The stream of graduate students coming to our institute increases year after year, as does the number of countries from which they come. At the present time the institute has 33 foreign graduate students from 14 countries (Bulgaria, East Germany, Czechoslovakia, Mongolia, Vietnam,

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Cuba, Algeria, Afghanistan, Laos, Syria, Bangladesh, Guinea, India, and Mexico). In the future the Moscow Geological Exploration Institute will strengthen the international bonds of friendship in the field of higher education, remembering the words spoken by Comrade L. I. Brezhnev at the 18th Congress of the All-Union Leninist Komsomol: "Soviet people, raised in the fraternal family of peoples and indoctrinated in the ideas of Marxism-Leninism, are internationalist by their very nature."

The collective of the institute is persistently working to expand its material-technical base, building a new MGRI complex in Chermushkinskiy Rayon in Moscow and also building new facilities at the Zagorsk and Crimean training sites. In the last 10 years a student dormitory with 280 places, a new boiler room, a warehouse, metal sheds for all training and scientific vehicles, and subdepartmental scientific research stands have been built at the Zagorsk training center. A stadium has been constructed and vehicle roads fixed up. This base has become a lively place to conduct practical science projects and competition during the summer, hold sports-health camps for college and secondary students during the winter vacation, and organize study for Komsomol and trade union activists. Each August a ceremonial student initiation and celebration of the beginning of the school year is held there.

Construction on the teaching and laboratory wing and dining hall at the Crimean training center near the city of Bakhchisaray is nearing completion. The boiler room and various administrative buildings have already been built. The next thing will be construction of a well-appointed student dormitory.

The collective has done a great deal of hard work on construction of the new MGRI complex in Moscow. Its total estimated cost is about 14.0 million rubles. In 1976 the Rudoznatsy Student House with 1,391 places was put into use, and in 1977 the Rodonit dining hall, seating 450, was opened. At the present time construction and installation on the teaching and laboratory wing with a total area of 34,000 square meters is at its peak and a great deal of preparation is underway to supply equipment for the new classrooms, laboratories, and offices in the building.

In recent years the teaching and total area of the old buildings has been increased slightly through redesigning, construction of storage space and a room for copying equipment, and putting the two-story wing No 4 in the yard of the institute into use. Nonetheless, the institute is presently forced to lease about 10,000 square meters of space in different parts of the city for its scientific work, and, of course, this makes the work of our associates more difficult.

When construction of the new complex is completed early in the 11th Five-Year Plan, our collective will be closer than ever to meeting the exceptionally great challenge of turning the Moscow Geological Exploration Institute into a model higher educational institution in our beautiful capital, the hero-city of Moscow. We will struggle for

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this with the same inspiration shown by students and graduates of MGRI during the first voluntary work Saturdays to rebuild the national economy devastated by the Civil War, at the construction sites of the first five-year plans, at the fronts of the Great Patriotic War and rebuilding the ruined economy after the victory, on the virgin land, at the Komsomol construction sites of the Moscow Metro, the ring highway, the V. I. Lenin stadium, Moscow State University, the sovkhoses and kolkhozes of Volokolamskiy Rayon of Moscow Oblast, as we build our new institute.

Upon entering its seventh decade, the collective of our institution set out with enormous enthusiasm to fulfill the plan of the fourth year of the 10th Five-Year Plan and is outlining its basic lines of development until 1990 in excellent spirits, with optimism and confidence. In these anniversary days, on behalf of the entire collective, I am very pleased to congratulate every graduate of every year on the glorious 60th birthday of the Moscow Geological Exploration Institute and I sincerely wish that every graduate may enjoy new labor accomplishments, bringing glory to the alma mater in the name of the prosperity of our beloved Soviet Motherland.

I hope that all those studying and working at our remarkable institution today will be worthy of the great achievements of their glorious predecessors, that they will keep pure everything that has been attained by their titanic labor over 60 heroic years and that they will make their own significant contribution to the glorious history of our institute.

Our trusty compass in the noble cause of training highly qualified specialists for the Motherland will continue to be the immortal teachings of Vladimir Il'ich Lenin, who said "Study, study, study...communism," creatively implementing the decisions of the party and government and making maximum use of the inexhaustible potential of our developed socialist society.

Lenin's order always to move forward, always to strive for more, will always be our rule in daily life.

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PHOTOS

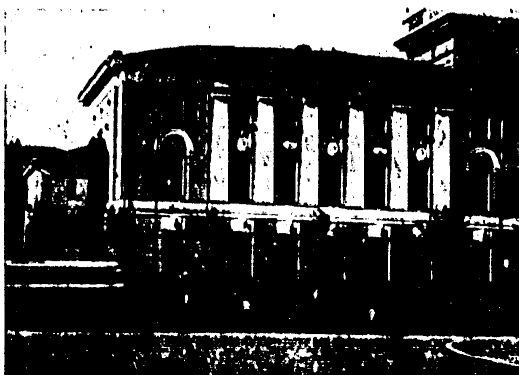


Figure 1. Main building of institute on Marx Prospect, 18



Figure 2. Prorector professor N. I. Yegorov in the Hall of Colleagues of the USSR Ministry of Geology gives out diplomas to mining engineer-geologist graduates of the 1978 jubilee year. A. A. Pogibel'nyy receives a diploma and a testimonial.

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Figure 3. Opening speech is given by Rector professor D.P. Lobanov before a lecture of A. Ye. Kozlovskiy of the USSR Ministry of Geology in auditorium # 20, December 1977.



Figure 4. Professor Ye. A. Kozlovskiy lectures on the "Basic Problems of the Development of the Raw-materials Base and the USSR Geological Service" before graduates and instructors of the institute.

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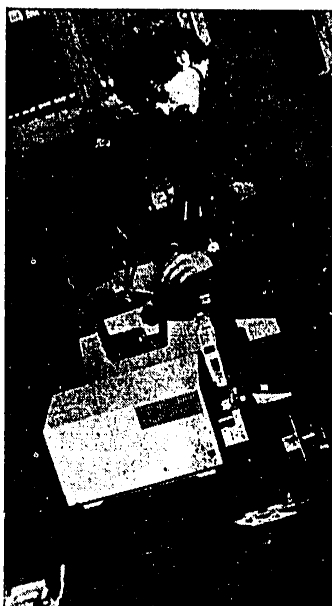


Figure 5. One of the scientific-study laboratories of the Department of Mathematics.

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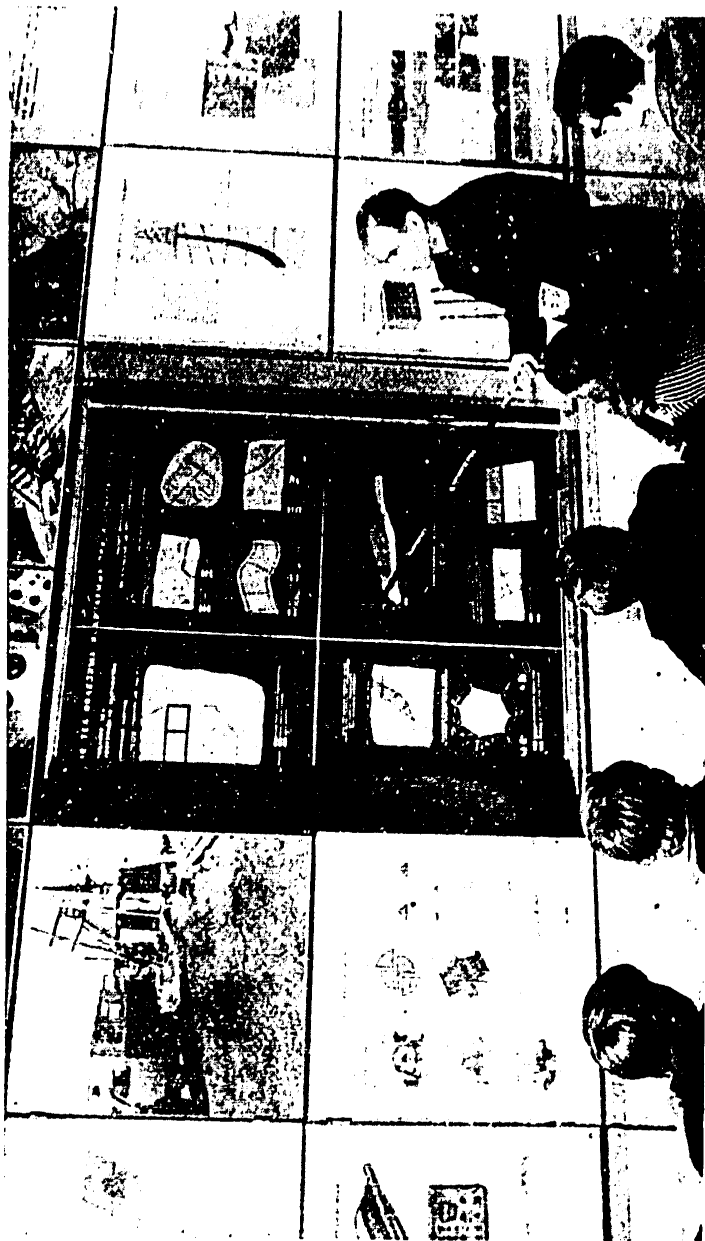


Figure 6. Study-methods office on prospecting for useful minerals (lesson given by Professor A. B. Kazhdan)

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Figure 7. Halls of the Mineral Ores Museum and the Geology-Paleontology Museum of the Institute

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Figure 8. A group of foreign graduates at one of the buildings of the institute after the handing out of diplomas at the end of MGR1.

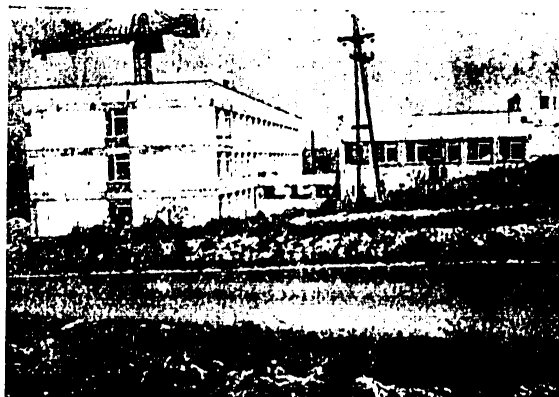


Figure 9. Study-laboratory building under construction at the Guinean Study Site.

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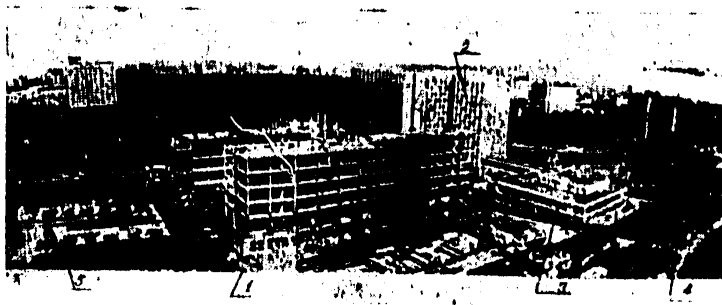


Figure 10. Panorama of a new institute complex under construction (for July 1978) 1-Study-laboratory building; 2-Dormitory "Rudoznattsy"; 3-Dining facility "Rodonit"; 4-Stadium; 5-Foundation of future "Aktovyy Hall".

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HISTORY OF THE GEOPHYSICS DEPARTMENT AT MGRI

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA
in Russian No 3, 1979 pp 92-98

[Article by D. S. Dayev and L. L. Lyakhov: "The Geophysics Department
of the Moscow Geological Exploration Institute"]

[Text] The history of the geophysical department at MGRI [Moscow Geological Exploration Institute] is closely linked to the formation and development of the geophysics specialization in Soviet higher education. This specialization first appeared in 1928 in the physico-mathematical department of Moscow State University, then in 1930 was transferred to the newly formed Moscow Geological Exploration Institute, where it finally took shape as an applied field of geological exploration.

The geophysics department at MGRI consisted of four special subdepartments corresponding to the basic branches of exploration geophysics: electrometry and magnetometry (headed by professor A. I. Zaborovskiy); gravimetry (headed by professor L. V. Sorokin); seismometry (first headed by professor V. F. Bonchkovskiy and later by academician G. A. Gamburtsev); radiometry (headed by professor V. I. Baranov); and the three general subdepartments of mathematics, mechanics, and electrical engineering.

The first graduation of specialists in geophysical exploration took place in 1931. The first curricula envisioned training specialists in particular techniques of exploration geophysics, but in 1932 the institute began training specialists in the broad field of exploration geophysics. In the same year of 1932 the four special subdepartments were joined in the subdepartment of general geophysical methods, headed by professor A. I. Zaborovskiy.

Professor A. I. Zaborovskiy headed the geophysics department from its formation until 1954; from 1954 until 1958 the head of the department was professor A. G. Tarkov, followed by docent L. L. Lyakhov in 1958-61, docent D. F. Zimin in 1961-70, docent L. L. Lyakhov again in 1970-1975, and from 1975 until the present by professor D. S. Dayev.

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The curriculum and syllabi of courses, laboratory classes, and practical training have changed somewhat as the particular methods of exploration geophysics developed and special attention was given by industry to prospecting for and exploration of particular types of mineral products. For example, in connection with the increase in prospecting for and exploration of deposits of radioactive raw material and the rapid development of radioactive techniques in 1949-1950, the special field of geophysical methods of prospecting for and exploring deposits of radioactive elements was introduced and the subdepartment of radiometric and nuclear physical methods was formed. This subdepartment was headed by professor V. I. Baranov until 1958, by docent A. S. Serdyukov in 1958-1968, and by professor A. G. Tarkhov from 1970 until 1978.

In the 1960's three specializations were created within the primary geophysical specialization: ore, structural, and drilling geophysics. At the same time broadly educated engineer-geophysicists continued to be trained, but they made a deeper study of the investigative methods of one of these fields of exploration geophysics.

In 1951-1956 the department was assigned to train geologists in the specialization "The Geology and Exploration of Deposits of Radioactive Elements." At this time the department was the largest at MGRI in number of students and organizing the learning process made great demands on the dean and major subdepartments.

The graduating subdepartment for exploration geophysicists in general geophysical methods was the subdepartment of geophysical methods of exploration, later renamed the subdepartment of exploration geophysics and then the subdepartment of general geophysical methods of exploration. Until 1956 the subdepartment was headed by professor A. I. Zaborovskiy, then from 1956 until 1965 by professor L. M. Al'pin, and in 1965-1978 by professor M. I. Plyusnin. In 1978 the subdepartment was divided into two: the subdepartment of seismic and well methods of exploration (headed by professor M. I. Plyusnin) and the subdepartment of electrical, gravitational, and magnetic methods of exploration (headed by professor D. S. Dayev).

The subdepartment of physics, which is a part of the geophysics department, has been headed in different years by V. L. Levshin, academician P. P. Lazarev, professor A. A. Petrovskiy (a student and associate of A. S. Popov), professor B. M. Gokhberg, academician of the Academy of Sciences of the Belorussian SSR N. S. Akulov, and professor Ya. V. Kravtsov. Since 1965 professor V. G. Semenov has been its head. Professor V. T. Ter-Oganezov was head of the subdepartment of mathematics for many years; from 1962 until the present professor G. Ts. Tumarkin has been the head there.

The figures on training of exploration geophysicists in the department are interesting. Between 1930 and 1940 125 engineers were graduated; in 1941-1950 there were 201 graduates; in 1951-1960 the figure was 703; from 1961 to 1978 1,406 engineers have been graduated. In the prewar years more than 70 percent of the young specialists were assigned

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to the geophysical service of the petroleum industry and only six percent went to organizations working at ore deposits. The department is proud that the petroleum geophysics service that took shape as early as the years of the first five-year plans was formed primarily through the efforts of MGRI graduates (P. A. Pospelov, V. A. Khar'kevich, M. K. Polshkov, S. G. Komarov, N. A. Per'kov, A. N. Fedorenko, and others) and scientists of the department (A. I. Zaborovskiy, G. A. Gamburtsev, L. M. Al'pin, L. V. Sorokin, and L. A. Ryabinkin).

In the postwar years most of our graduates have been sent to organizations of the USSR Ministry of Geology for work in ore geophysics. A significant number of graduates of the department are also assigned to organizations of other departments such as USSR Gosstroy, RSFSR Gosstroy, the Ministry of Transport Construction, the Ministry of Land Reclamation and Water Resources, the Ministry of Power and Electrification, and others.

At the present time alumni of the department are working within the systems of the ministries of geology, the petroleum industry, the coal industry, and ferrous and nonferrous metallurgy, in the geological territorial administrations, trusts, offices, expeditions, and scientific institutes of these ministries, and at institutes of the Academy of Sciences USSR. They are teaching at many higher educational institutions such as Moscow and Saratov universities, the Moscow Institute of the Petrochemical and Gas Industry imeni academician I. M. Gubkin, the Kazakh Polytechnic Institute, the Groznyy and Baku petroleum institutes, and others. Department alumnus N. A. Sevost'yanov heads the geophysical service in the petroleum industry, and graduates of the department have headed or today head the leading scientific institutes in the country for the development of geophysical science: All-Union Scientific Research Institute of Geophysical Exploration Methods and All-Union Scientific Research Institute of Nuclear Geophysics and Geochemistry (professors M. K. Polshkov and Ye. V. Karus) and the All-Union Scientific Research Institute of Mineral Raw Materials (professor A. N. Yeremeyev). They are managing the development of geophysical methods of well testing and logging service in the petroleum industry (N. N. Soranov and A. S. Kashik) and are leading specialists of the geophysics service of the USSR Ministry of Geology (V. I. Fedyuk, A. S. Bazhenov, and others) and the RSFSR Ministry of Geology.

The geophysics groups at various scientific institutes, for example, the Central Scientific Research Institute for Exploration of Non-ferrous, Rare, and Noble Metals, the All-Union Scientific Research Institute of Mineral Raw Materials, the All-Union Scientific Institute of Marine Geology, the Institute of Earth Physics, and the Institute of Oceanology of the Academy of Sciences USSR, are largely staffed with graduates of the department. Many department graduates work in the field of prospecting for, exploration, and exploitation of deposits of rare and radioactive elements.

Our graduates have made a large contribution to the development and refinement of the theory and practice of geophysical methods. Their

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achievements and discoveries have been highly praised by the Party and Government: the work of N. P. Chunarev and B. V. Polovinkin received Lenin Prizes and 26 people have won the State Prize, among them A. M. Alekseyev, B. L. Gurevich, O. K. Glotov, K. Ye. Veselov, Yu. N. Voznesenskiy, S. N. Kondrashov, P. I. Lukavchenko, M. K. Polshkov, V. N. Rudnev, N. B. Sashina, N. I. Shapirovskiy, P. I. Sheshin, V. P. Fedorov, and A. N. Fedorenko. G. A. Selyatitskiy was awarded the title Hero of Socialist Labor. Many geophysicists have been granted orders and medals for discovering deposits and for scientific and production achievements (A. N. Yeremeyev, M. I. Kiselev, L. Ch. Pukhal'skiy, L. M. Al'pin, I. I. Gurvich, V. P. Nomokonov, and others). More than 40 alumni of the department have defended doctoral dissertations and about 200 have received candidate of sciences degrees.

The development of the specialization demanded constant improvement and updating of the courses offered and development of new courses. All the special courses were revised with application to the new specializations. New courses entitled "Combining Geophysical Techniques" (professors A. G. Tarkhov and M. I. Plyusnin and docents A. I. Dyukov and V. V. Brodovoy), "Recording and Processing Geophysical Information" (docents A. A. Nikitin and G. N. Boganik), and "Theoretical Foundations of Exploration Geophysics" (professors A. M. Al'pin and D. S. Dayev) appeared. The course "Exploration Geophysics" was fundamentally revised for the geological and mining specializations (professor Yu. V. Yakubovskiy and docents L. L. Lyakhov, N. D. Kovalenko, I. N. Kadyrov, and V. M. Bondarenko) and a new course "Geological Interpretation of Geophysical Data" was instituted.

The subdepartment of radiometric and nuclear physical methods developed courses in radiometry, mine radiometry, nuclear geophysics, and dosimetry (professor V. I. Baranov and docents A. S. Serdyukova, L. V. Gorbushina, D. F. Zimin, V. G. Tenyayev, and Ye. I. Savenko) both for the geophysics specialization and for geological specializations. In shaping the specialization, the subdepartment did a great deal of scientific methods work to set up a modern laboratory course in radiometric and nuclear geophysical methods, develop teaching aids, organize production practice, and establish a radiometric training center. Since 1970 the subdepartment has developed and introduced courses in the application of mathematical statistical methods of processing geophysical observations (A. G. Tarkhov, A. A. Nikitin, and G. V. Demura).

The subdepartment of mathematics has done a great deal to insure a high level of mathematical training for students in all specializations, not just geophysics students. At the present time more than 80 percent of the teachers in the subdepartment have basic university education and more than 70 percent have academic degrees. In the 1960's the collective of the subdepartment modernized the general course in higher mathematics and introduced new courses in "Programming" and "Computer Technology in Engineering-Economic Calculations." They introduced machine mathematical methods for course and diploma projects based on the computer laboratory set up in 1969 with rooms for electronic and keyboard machines. Work is underway to design and introduce plans

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for continuous mathematical training of students in all specializations. By persistent methods work the collective of the subdepartment was able to bring the level of teaching of mathematics close to the requirements of the specialized and major disciplines and give students practical skills in appropriate mathematical calculations.

The physics subdepartment has always done a great deal of methods work to revise the content of lecture courses and laboratory cycles with reference to the requirements and specific features of particular specializations. Thus, professor A. A. Petrovskiy introduced the "Special Course in Electricity for Exploration Geophysicists"; questions of solid state physics are now separated out in an independent section and the laws of potential fields, oscillations and wave processes of mechanics, electromagnetism, and optics are studied in parallel.

Teachers of the department have written many textbooks and teaching aids. In the prewar years they wrote the world's first textbooks for geophysics students: G. A. Gamburtsev's "Seismic Exploration," A. I. Zaborovskiy's "Electrical Exploration," "Terrestrial Magmatism," and "Special Functions," and L. V. Sorokin's "Gravimetric Methods of Exploration." In the postwar years many more works were published, including "Radiometry" by V. I. Baranov, "Field Theory" and "Practical Projects in Field Theory" by L. M. Al'pin, "Radiometric and Nuclear Physical Methods of Prospecting" by L. V. Gorbushina, D. F. Zimin, and A. S. Serdyukova, "Seismic Exploration" by I. I. Gurvich, "Electrical Exploration" by Yu. V. Yakubovskiy, and "Electrical Exploration" by Yu. V. Yakubovskiy and L. L. Lyakhov. Some of these books came out in several editions and were translated into foreign languages. G. A. Solov'yev published the textbook "Introduction to Field Theory" in India in the English language. Associates in all the subdepartments of the department have written more than 60 teaching aids in particular areas of the courses offered, for practical classes, laboratory projects, and practical geophysical training.

Scientific work has always played a large part in the activity of the department; it is a significant determining factor in the level of pedagogical activity of the teachers and the quality of graduating specialists. In the prewar years the primary scientific interests of the geophysics subdepartments dealt with working out the fundamentals of the theory and interpretation of different geophysical methods: electromagnetic (A. I. Zaborovskiy, L. M. Al'pin, and V. O. Uryson), seismic (G. A. Gamburtsev and L. A. Ryabinkin), electrical logging and dipole techniques of electrical exploration (L. M. Al'pin), radiometry (V. I. Baranov), gravimetry (L. V. Sorokin and Ye. A. Mudretsova), and magnetic exploration (Ye. A. Mudretsova and A. I. Petrov). At the same time teachers and associates of the department carried out field projects to develop and introduce new methods of geophysical testing and participated in prospecting for and exploring deposits of mineral products in the Kura Lowland, the Southern and Central Urals, the Alatau, and the Arctic (A. I. Zaborovskiy, L. M. Al'pin, Ye. K. Baranov, A. A. Petrovskiy, L. V. Sorokin, and others).

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Rapid growth in scientific work began immediately after the end of the Great Patriotic War, which was a result of the abrupt, general enlargement of geological and geophysical studies in the USSR. The scope of scientific work has been particularly broad in the last decade, when the annual volume of scientific research projects for the special subdepartments has reached 250,000-300,000 rubles. Unlike the situation in the prewar years, the geophysics subdepartments have received the opportunity to conduct comprehensive geophysical studies together with other subdepartments of the institute and with production organizations. Projects of this type were carried out in 1946-1949 in the Carpathians, in 1950-1952 in the suburban Moscow basin (jointly with the Geofizuglerazvedka [Geophysical Coal Exploration Trust]), in 1952-1954 in the Karatau (jointly with the South Kazakhstan Geological Administration and the Kazakh Geophysical Trust), in 1957-63 in the Transbaikal, in 1970-1971 in North Kazakhstan, and elsewhere. These projects have provided the basis for the formation of scientific collectives, involving students in scientific research work, and broadening the training of graduate students. In addition, associates of the department are conducting major studies in particular scientific areas: inductive electrical exploration (Yu. V. Yakubovskiy, F. M. Kamenskiy, I. A. Dobrokhotova, and others), the aerial version of the crossing processes method (F. M. Kamenetskiy, V. M. Timofeyev, and P. P. Makagonov), induction logging (M. I. Plyusin, N. M. Afonina, B. I. Vil'ge, and others), high-frequency electromagnetic logging (D. S. Dayev and V. S. Zinchenko), theory of logging (L. M. Al'pin), underground geophysics (A. G. Tarkhov, V. M. Bondarenko, and others), seismic exploration (I. I. Gurvich, V. P. Nomokonov, and G. N. Boganik), radiometry (V. I. Baranov, A. S. Serdyukova, L. V. Gorbushina, D. F. Zimin, Ye. I. Savenko, and others), the application of mathematical statistical methods and information theory to the processing of geophysical materials (A. G. Tarkhov, A. A. Nikitin, I. I. Gurvich, G. N. Boganik, O. A. Demidovich, and others). Since 1976 the department has been involved in research in the field of marine geophysics, working on the problem of prospecting for and exploring coastal and offshore deposits of solid mineral products (L. L. Lyakhov and others).

Among the results of research work have been development of the theory, apparatus, and methodology of the ungrounded loop method, the crossing processes method, the aerial version of the crossing processes method, induction dielectric logging, underground gravimetric exploration, the method of underground recording of cosmic radiation, new techniques of mine seismic exploration, mathematical methods of geophysical interpretation, and apparatus and techniques for continuous acoustic profiling. Various monographs have been published on the basis of research results: "Theory of Dipole Probing" (L. M. Al'pin), "Geophysical Exploration by the Induction Method" and "Foundations of Geophysical Exploration by the Radioactive Stacks Method" (A. G. Tarkhov), "The Induction Method of Electrical Exploration" (Yu. V. Yakubovskiy), "Induction Logging" (M. I. Plyusnin), "Underground Geophysics" (A. G. Tarkhov, Ye. A. Mudretsova, V. M. Bondarenko, M. O. Lakhtinov, and N. D. Kovalenko), "High-Frequency Electromagnetic Methods of Well Testing" (D. S. Dayev), "Principles of Aggregation in

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Exploration Geophysics" (A. G. Tarkhov, V. M. Bondarenko, and A. A. Nikitin), "The Use of Cosmic Rays in Geology" (V. M. Bondarenko), "The Muon Method of Analyzing the Density of Rocks" (V. M. Bondarenko and G. G. Viktorov). Seven doctoral dissertations and 35 candidate dissertations have been defended, eight medals of the Exhibition of the Achievements of National Economy awarded, and more than 50 author's certificates and patents received. The State Committee for Discoveries and Inventions has registered a scientific discovery in the field of predicting earthquakes that was coauthored by L. V. Gorbushina, a docent in the subdepartment of radiometric and nuclear physical methods. Teachers and associates from the subdepartments of physics and mathematics such as G. A. Solov'yev, P. P. Makagonov, M. N. Smirnova, O. P. Lukina, T. A. Trofimova, I. V. Il'in, N. I. Mukhina, M. N. Yudin, and others have participated in these projects.

Scientific work in the subdepartment of mathematics is pursued in both the field of pure mathematical research and in applied mathematics. In the prewar years and first years after the war the volume of scientific work in the subdepartment was limited by the small staff size (5-7 teachers). Research was carried on in the fields of astronomy (V. T. Ter-Oganezov), function theory (G. Ts. Tumarkin and K. V. Yefremov), and number theory (N. I. Fel'dman). With the significant broadening of student mathematical training and introduction of mathematical methods in scientific research at the institute in the 1960's the number of teachers tripled and, moreover, a computer laboratory was set up with an appropriate staff of programmers and electronics experts and graduate student training was begun.

Associates of the subdepartments came to participate actively in the scientific projects of the geophysical subdepartments, but applied research developed with particular intensity on the application of function theory, mathematical programming, and numerical methods in developmental work on mining geological, economic geological, engineering-hydrogeological, and geophysics topics. Various forms of joint studies with other subdepartments were developed extensively.

Among the scientific achievements of the subdepartment in the field of "pure" mathematics we should note the fundamental results obtained by G. Ts. Tumarkin on the boundary properties of analytic functions and approximation by polynomials and rational fractions with given poles. He reported his results at international and All-Union congresses and conferences and they were translated into English, French, German, and other languages.

In the field of the application of mathematical methods to theoretical physics and mechanics, we should note S. V. Temko's formulation of a theory of limited physical systems and docent Ya. R. Berman's work in the field of applying the techniques of the mathematical theory of currents to problems of the hydraulics of hydroengineering structures.

Foremost among works on the application of mathematical methods in prospecting for and exploration and exploitation of deposits of mineral

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products we should mention research on the use of methods of planning and experiment to optimize drilling regimes (professors Ye. A. Kozlovskiy and G. Ts. Tumarkin). The studies involving formulation and solution of the problems of optimizing the extraction of underground water and drainage (professor G. Ts. Tumarkin, docents A. V. Mikhaylova, O. S. Gorbacheva, S. V. Temko, and others), conducted jointly with the subdepartment of hydrogeology, are very important. Docent P. P. Makagonov developed the first system of software for inductive electrical mine exploration. Docent M. A. Ortenberg published a monograph "Methods of Delineating Metamorphic Complexes," together with coauthors from the subdepartment of mineralogy.

Successful development of the questions of applying mathematical methods and computer technology in prospecting for and exploration and exploitation of deposits of solid mineral products and underground waters has yielded an economic impact of more than 2 million rubles from introduction in recent years. Associates of the subdepartment have received five medals and various participation diplomas from the Exhibition of the Achievements of the National Economy for work on the application of mathematical methods and have defended two doctoral and 12 candidate's dissertations.

In the first years of existence of the subdepartment of physics its scientific work under the direction of Professor V. L. Levshin (who later won the State Prize) was oriented to the field of polarized luminescence, establishing links between spectra of absorption and luminescence, and determining the effect of various physicochemical factors on luminescence. In 1937-1938 professor A. A. Petrovskiy conducted studies in the field of radiowave transmission at the subdepartment. After 1965, when V. G. Semenov became head of the subdepartment, the scientific and pedagogical collective has concentrated its attention on the problem of the physics of rock and phenomena, which has two special areas: applied thermal studies and the physics of rocks.

Work on applied thermal studies began in 1972 (M. O. Lakhtionov, S. M. Skorniyakov, and others) under the general direction of professors A. G. Tarkhov and V. G. Semenov. The positive results obtained in testing thermal exploration at various types of deposits and in different geological-tectonic conditions led to the establishment of a sectorial laboratory with 14 associates in the subdepartment. The laboratory collective is working on development of the physical foundations of thermal exploration and the methodology of observations in a layer of variable temperatures. They are studying the interrelationship of the thermal properties of rocks and ores with other petrophysical parameters. Apparatus for non-contact temperature measurement is being built (Yu. A. Popov).

In the field of the physics of rocks research is underway on the physical properties and phenomena of cryogenic rocks (A. D. Frolov and B. V. Gusev) and study of the spatial zonality of the physical properties of rocks and ores within hydrothermal deposits (G. A. Solov'yev).

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The results of research on the physics of cryogenic rocks were set forth by A. D. Frolov in the monograph "Electrical and Elastic Properties of Cryogenic Rocks."

The monograph by professor V. G. Semonov "Fluctuations of General Atmospheric Circulation and Long-Term Forecasts" and the project initiated by docent N. P. Novikov on a laser technique of analyzing the physical properties of rocks also deserve attention.

Since 1949-1950 associates of the department have participated actively in assisting the countries of the socialist community and developing countries in geophysical studies. This has been expressed above all in training engineer-geophysicists. Students from many countries have studied in the department: Bulgaria, Hungary, East Germany, Czechoslovakia, Vietnam, Yugoslavia, Mongolia, North Korea, the PRC, Cuba, Albania, Algeria, Ethiopia, Lebanon, Morocco, Cam roon, Mali, Nigeria, Somali, the United Arab Emirates, Gabon, and the Yemeni Arab Republic. During this time 115 engineer-geophysicists have been trained. Fifteen candidates of science have been prepared for scientific institutions and higher educational institutions in Bulgaria, Vietnam, India, Hungary, and other countries through graduate study and on-the-job training. The collective of the department has been assigned the duty of giving scientific methods help in establishing the department of geophysics at Osman University. Professors M. I. Plyusnin, I. I. Gurvich, A. G. Tarkhov, D. S. Dayev, and G. Ts. Tumarkin, doctor of technical sciences F. M. Kamenetskiy, and docents A. A. Nikitin, V. M. Bondarenko, G. A. Solov'yev, Ye. I. Savenko, and V. M. Timofeyev have traveled to Osman University to give lectures, organize scientific work, and direct teacher trainees on the job. Associates of the department have participated in programs of scientific-technical aid to India (V. P. Nomokonov and D. S. Dayev).

Docent V. P. Nomokonov helped organize the subdepartment of exploration geophysics and the geophysics specialization at the Sofia Mining Geological Institute. Professor Yu. V. Yakubovskiy spent two years as head of the subdepartment of geophysics at the Algerian petroleum center. Docent V. V. Chebykin is head of the department of physics at the Algerian Polytechnic Institute today. Associates of the subdepartment have taught at institutes of various countries for many years: professor I. I. Gurvich at the Beijing Geological Exploration Institute; docent G. G. Viktorov at the Guinea Polytechnic Institute; professor G. Ts. Tumarkin at the Sofia Mining Geological Institute and the Shumanskiy Pedagogical Institute in Bulgaria. Associates of the department are providing scientific consultation to various higher educational institutions and science-production organizations in foreign countries today on the basis of contracts for cooperation.

The department is celebrating the 60th anniversary of the institute by strengthening the educational and indoctrination process further, developing scientific research work, and improving its efficiency while focusing the efforts of the entire collective of teachers, associates, and students on meeting the challenges posed by the 25th CPSU Congress.

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SCIENTIFIC AND TECHNICAL INFORMATION DISSEMINATION IN SCIENTIFIC-RESEARCH INSTITUTES

Moscow NAUCHNO-TEKHNICHESKAYA INFORMATSIYA, SERIYA 1, ORGANIZATSIYA I METODIKA INFORMATSIONNOY RABOTY in Russian No 2, Feb 79 p 26

[Article by S.M. Matveyev: "Organization of Scientific and Technical Propaganda in a Scientific-Research Institute]

[Text] In speeding up scientific and technical progress as a decisive factor in boosting the efficiency of socialized production, a major role belongs to scientific and technical propaganda--an important part of scientific information activity. Today it is impossible to ensure effective adoption of scientific and technical achievements without wide-scale propaganda of them, that is, dissemination, elucidation and publication.

The scientific and technical propaganda group of the department of scientific and technical information at the Ural Scientific-Research and Planning Institute of Construction Materials (UralNIISTromproyekt) consists of an engineer for scientific and technical propaganda, two artists-designers and a photographer. A number of functions connected with the dissemination of achievements of science and technology are performed by personnel of other subdivisions of the department of scientific and technical information; preparation of information sheets, publication of scientific works, recommendations and methodological instructions are done by the editorial and publications group, while the abstracting of descriptions of the more significant inventions by colleagues of the institute recommended for adoption is performed by the patent and licensing group.

The purpose of scientific and technical propaganda is dissemination of the latest scientific and technical achievements tested in practice and of advanced production experience on the scale of the industry or of the country as a whole. In the work of the group, use is made of the most popular forms, methods and means of disseminating scientific and production and technical achievements that meet the requirements of concreteness, persuasiveness, wide accessibility, systematic character, consistency, clarity and understandability; different exhibits are organized, promoting the efficient introduction into production of all that is new and progressive, which contributes to

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raising productivity of labor, economy of metal, construction materials, energy resources and the like. The exhibits inform scientific and engineering and technical personnel of the newest scientific and technical achievements in the USSR and abroad; models, samples of materials and diagrams of new production lines are prepared for them (the exhibits are accompanied by labels and explanatory sheets).

A permanent exhibition dealing with problems of economy of metal and other construction materials is to be found at the institute. Developments of the institute are widely represented in the exhibition hall of the RSFSR Ministry of Construction Materials. At the exhibit dealing with work in economy of metal organized by the Chelyabinsk CPSU Obkom, the Center of Scientific and Technical Information, and the Oblast Trade-Union Council, five works of the institute were shown; three of these had been displayed at the USSR Exhibition of National Economic Achievements and received two diplomas and several medals.

An interesting exhibition was conducted by the institute--"Contribution of Scientific and Technical Information Services to the Performance of Scientific Research Work at the Level of World Newness," the materials of which dealt with information servicing of leading scientific developments of the institute and illuminate the effectiveness of the developments (economic gains of introduction, economy of metal and construction materials, energy resources and the like).

A subdivision of scientific and technical propaganda has a calendar card file of conferences, meetings, seminars and the like planned in the country. The file includes the most important topics of conferences and seminars drawn from the annual plans of the Ministry of Construction Materials, scientific and technical departments of "Stroyindustriya," scientific and technical propaganda houses, centers of scientific and technical information, scientific societies, institutes and so on. It is possible to find out about forthcoming international conferences from the "Bulletin of Commercial Information."

The subdivision of scientific and technical information compiles the necessary documentation, keeps records and provides methodological assistance to specialists.

The department of scientific and technical information jointly with the Chelyabinsk Information Center annually makes one or two short films on the significant developments of the institute. The scientific developments of the institute are systematically propagandized on television, radio, in the local and central press and by way of information sheets. As a rule, colleagues of the department of scientific and technical information appear as coauthors with specialists.

Each year the institute puts out a typewritten collection "Annotations of the Most Important Scientific and Technical Developments" in 30-40 copies), which is then sent to enterprises and institutions of the sector of the construction

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materials industry. Information cards are compiled on finished and intermediary reports on scientific-research work, the abstracts of which are published in the collection.

Where scientific articles by virtue of unappropriateness of subject matter cannot be included in the issued collections, they are deposited, while observing in this connection the complete cycle of processing at the department of scientific and technical information.

Colleagues of the institute receive annually 50-60 patents for inventions, which are propagandized in abstract journals and also included in brief annotations in the collection published by the institute.

For the most part, albums of color and black-and-white photographs are prepared of the institute's developments.

The subdivision of propaganda takes part in the organization of technical instruction, in the process of which leading developers and abstractors acquaint the colleagues of the department of scientific and technical information with the subject matter of their work.

The propaganda group has in addition to the card file on conferences: a card file of the passage of scientific-research work from the developer to the institutes scientific and technical library; an address card file providing specialists with data on plants and organizations connected with the institute and a card file of the effectiveness of expenditures on scientific-research work and the effectiveness of introducing developments into production.

The department of scientific and technical information has accumulated experience in inspections on scientific and technical information and inventions.

The dissemination of scientific and technical achievements is conducted by colleagues of the department of scientific and technical information jointly with specialists and public organizations of the institute--scientific and technical departments, the All-Union Society of Inventors and Innovators and the primary organizations of the Znaniye Society.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

UDC 651.926.08

MANAGING TRANSLATORS, PATENT WORKERS AND EXPORT-SERVICE PERSONNEL

Moscow NAUCHNO-TEKHNIЧЕСКАЯ ИНФОРМАЦИЯ, СЕРИЯ 1, ОРГАНИЗАЦИЯ
I МЕТОДИКА ИНФОРМАЦИОННОЙ РАБОТЫ in Russian No 2, Feb 79 p 27

[Article by V.P. Tkach: "Organization and Methodological Guidance
of the Work of Translators, Patent Workers and Export-Service Personnel"]

[Text] The scientific and technical translation section created ten years ago under the Ural House of Scientific and Technical Propaganda (UDNTP) of the Znaniye Society has established close ties with the country's scientific centers (VtSP [All-Union Center of Propaganda]) All-Union Scientific-Research Institute of Technical Information, Classification and Coding, Moscow State University, Institute of Linguistics and Institute of Philosophy of the USSR Academy of Sciences), industrial enterprises, party organs, trade-union and other public organizations, as well as with Chelyabinsk's higher educational institutions (university, polytechnic and pedagogic institutes, Institute of Mechanization and Electrification of Agriculture) and with higher educational institutions of the Ural region.

The chief defect of methodological work with translators in regional creative associations, such as NTP [scientific-technical propaganda] sections under managing boards of scientific-technical departments, has been and still is lack of necessary attention paid to theoretical training of translators. Our NTP section has been able to overcome this deficiency to a significant degree by involving scientists and specialists from the fields of philosophy, logic, sociology and psychology in the work of the section.

Section personnel acquaint translators with translation theory and inculcate in them the necessary techniques of practical work and also inform them of present-day achievements in the field of social-political and economic sciences.

Skills of translators of scientific and technical literature and documentation are upgraded by study at the "Polytechnical Minimum" school-seminar, which has been conducted for a number of years on a yearly basis. It acquaints students with the following topics: technology of metals, resistance of materials, parts of machines, technical measurements, tolerances, fittings

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and also with the fundamentals of electronics, radio and computer technology. After such an excursion into the field of the technical disciplines, translators will be able to independently broaden their knowledge in the field of their work. The school-seminar has attracted translators from many cities of our country. In 1967, there took part in it 84 persons from 67 enterprises.

Another task of the ural area NTP section is methodological guidance of proper making up of export, technical, advertising and product-accompanying documentation, which is very important, as these types of documentation serve abroad as a visiting card for an enterprise. They not only contain technical data but also provide evidence of the USSR's scientific and technical progress.

For the purpose of improving the quality of export documentation, the NTP section jointly with representatives of the Ministry of Foreign trade carry out surprise visits to verify the make-up and format of product-accompanying documentation at enterprises of the city. With the same objective in mind, area "Techniques of Translating and Editing" and "Scientific-Technical Progress and Problems of Translation of Scientific and Technical Literature and Documentation" schools-seminars were held and attended by 300 persons from 208 enterprises.

A significant place at the Ural House of Scientific and Technical Propaganda is given to work with translators of patent and licensing documentation, which are sources of information of great importance to scientific and industrial organizations. Not only are conferences and schools held for translators and authors-compilers but consultations are also given on compilation and translation of export documentation. Preparatory work for analysis of the professional preparedness of translators is also done.

The participation of section members in scientific and theoretical conferences and seminars permits keeping track of everything new appearing in the work of translating services at home and abroad. Many major specialists in the field of scientific and technical translation and related disciplines are invited to Chelyabinsk for exchanges of experience. Members of the NTP section perform work in the field of translation theory and generalize the experience of the best translators.

The scientific and technical propaganda section of the Ural House of Scientific and Technical Propaganda has set itself the following tasks:

--to involve on a broader scale in the work of the section specialists working in the sphere of scientific and technical information and in related fields;

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--to provide closer working contacts between translating subdivisions and individual translators, using different forms of contacts for these ends;

--to coordinate the activity of the section with current and long-term tasks of the national economy.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

MOISEY DAVYDOVICH GANDLEVSKIY (1904-1979) OBITUARY

Moscow NAUCHNO-TEKHNICHESKAYA INFORMATSIYA, SERIYA 1, ORGANIZATSIYA
I METODIKA INFORMATSIONNOY RABOTY in Russian No 2, Feb 79 p 29

[Text] Moisey Davydovich Gandlevskiy, a prominent figure in the field of scientific and technical information, died unexpectedly on 6 January 1979.

M.D. Gandlevskiy's career spanned from being a worker in a machine-building plant to deputy director for scientific work of the Scientific-Research Information Institute for Machine Building. Possessing much experience in organization of production, M.D. Gandlevskiy headed since 1944 the creation of information systems in a number of sectors of the national economy.

His name is connected with well-known works in the field of organization of scientific and technical information, planning and introduction of sectorial automated systems and international cooperation in the sphere of scientific information activity.

High party qualities, outstanding leadership capabilities, profound professional skills and personal human qualities gained for M.D. Gandlevskiy merited prestige, love and the respect of all who worked with him. He was characterized by a special vision of the information process, boldness in looking for nonstandard solutions, determination and tact in their realization. The combination of exactingness and gentleness marked the basic and unforgettable feature of M.D. Gandlevskiy's style.

A bright memory of Moisey Davydovich Gandlevskiy, true son of the Communist Party of the Soviet Union, a person of high culture and noble soul, will always be retained in the hearts of his colleagues.

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PUBLICATIONS

GEOMETRICAL THEORY OF DIFFRACTION

Moscow GEOMETRICHESKAYA TEORIYA DIFRAKTSII in Russian 1978 signed to press
28 Aug 78 p 2, 246-247

[Annotation and table of contents from book by Vladimir Andreyevich Borovikov
and Boris Yevseyevich Kinber, Izdatel'stvo Svyaz', 3000 copies, 248 pages]

[Text] This book is devoted to an account of a new and quite effective trend
in the theory of diffraction, which is suitable for application in engineering
practice in designing antennas and channels for the UHF, SHF and EHF bands,
as well as in the area of wave propagation. It represents the first systematic
account of the geometrical theory of diffraction.

This book is intended for scientific personnel working on questions related to
channeling system equipment and radiowave emission and propagation.

Contents	Page
Foreword	3
Introduction	5
Chapter 1. Fundamentals of the Geometrical Theory of Diffraction	
1.1. Laws of geometrical optics	11
1.2. Postulates of the geometrical theory of diffraction	14
1.3. Diffraction in a slit. Expressions for edge waves in terms of diffraction coefficients	18
1.4. Diffraction in a slit. Explicit expressions for edge waves	23
1.5. Reconstruction of an antenna diagram by measurements of its close-range field	27
1.6. Limits of applicability of GTD [geometrical theory of diffraction]	30
Chapter 2. Beam Fields in Homogeneous Media and Their Reflection from Smooth Bodies	
2.1. Beam resolution	31
2.2. Eikonal equation and transport equation	32
2.3. Limits of applicability of beam resolution. Conversion in terms of caustic curves	37
2.4. Beam resolution for very simple fields	38
2.5. Asymptotic solutions of problems concerning reflection	45

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2.6. Beam fields in irregular waveguides (smooth waveguide-horn junction)	49
2.7. Smooth junction between regular waveguides	54
Chapter 3. Caustic and Focal Expansions	
3.1. Uniform asymptotic expansions	63
3.2. Relationship between fronts and caustics	64
3.3. Coordinate systems in the vicinity of a caustic	68
3.4. Caustic expansions	69
3.5. Field in the vicinity of the asymptote of a caustic	72
3.6. Focal expansions	75
3.7. Diffraction integral	77
Chapter 4. Diffraction Waves	
4.1. Classification of diffraction waves	87
4.2. Diffraction of a plane wave in a half-plane. Half-shade fields	90
4.3. Diffraction of a cylindrical wave in a half-plane. Diffraction on a wedge	96
4.4. Diffraction in a slit	103
4.5. Diffraction of a random beam wave on a body with a discontinuity (two-dimensional problem)	107
4.6. Diffraction on a fin. Three-dimensional problem	112
4.7. Axisymmetric analog of diffraction on a wedge--diffraction of a toroidal wave on a bicone	115
4.8. Reference waves	
4.9. Reflection of a half-shade field from a smooth surface	125
4.10. Diffraction of a half-shade field on a wedge	130
Chapter 5. Relationship Between the GTD and Methods of Physical Optics	
5.1. Approach of Kirchhoff and the physical theory of diffraction	136
5.2. High-frequency asymptotic form of a field in the PK [Kirchhoff approach] and FTD [physical theory of diffraction]	140
5.3. Radiation of a reflecting antenna	147
5.4. Diffraction at an angular point of a loop	156
5.5. Diffraction at an aperture of random shape	160
Chapter 6. Diffraction on Bodies of Complex Shape. Waveguide Problems	
6.1. Phase structure of fields included in the solution	175
6.2. Method of successive diffraction (MPD)	180
6.3. Method of a self-consistent field (MSP)	181
6.4. Examples of calculations by the method of successive diffraction and the method of a self-consistent field	190
6.5. Waveguide problems (diffraction at the open end of a waveguide with a flange)	207
6.6. Waveguide problems (wide slit in the wall of the waveguide; discontinuity in a waveguide with a reflector)	220
Appendix 1. Relationship Between Curvature of Fronts in Reflection and Refraction of Waves	232
Appendix 2. Generalized Fresnel Integral	234
Appendix 3. Derivation of Equation for the Radiation Diagram of a Reflecting Antenna	236
Bibliography	240

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PUBLICATIONS

NEW BOOK ON EXPERIMENTAL METHODS, RESULTS WITH POWER REACTORS

Moscow FIZICHESKIYE ISSLEDOVANIYA REAKTOROV VVER in Russian 1978 signed
to press 6 March 78 pp 1-4, 177

[Annotation, table of contents, and preface of the book "Fizicheskiye
Issledovaniya Reaktorov VVER" (Physical Studies of Water-Moderated
Water-Cooled Power Reactors) by I. N. Aborina, Atomizdat, 2,500 copies,
120 pages]

[Text] Annotation

This work is devoted to description of experiments conducted to sub-
stantiate water-moderated water-cooled (WMWC) reactors and during
their launching and operation. The special features of the physics
of WMWC reactors and techniques of reactor experimentation known and
developed in the research process are set forth. The book presents
considerations with respect to possible experiments in WMWC reactors
to improve their operating characteristics.

This book is intended for specialists engaged in the study and opera-
tion of nuclear reactors and upper-division college students.

It has six figures, two tables, and 50 entries in the bibliography.

Table of Contents	page
Preface	3
Introduction	5
Chapter 1. Measurement in Subcritical and Critical Installations	13
1.1 Experiments to Substantiate the Active Zones of WMWC Reactors	13
1.2 Measurement of Microparameters	23
1.3 Measurement of the Area of Migration	33
1.4 Measurement of a Geometric Parameter	41
1.5 Studying the Energy Spectra of Neutrons	45

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	page
1.6 Measurement of Reactivity	57
1.7 Investigation of Control Elements	66
1.8 Investigation of the Energy Release with Spatial Disruption of the Homogeneity of the Grating	73
Chapter 2. Experiments During the Launching of the Reactor	76
2.1 Special Features of Experiments on Operating Reactors. Investigation of Asymmetry of Properties of the Active Zone.	76
2.2 Determining the Reserve of Reactivity and Differen- tial and Integral Efficiency of Control Rods	79
2.3 Measurement of the Temperature Coefficient of Re- activity	85
2.4 The Barometric Coefficient of Reactivity	92
2.5 The Power Coefficient of Reactivity	93
2.6 The Effect of Nonstationary and Stationary Con- tamination	95
2.7 Monitoring Inside the Reactor	99
2.8 Measurement of Energy Release (Thermal Power)	101
2.9 Experiments with Fuel Reloading	103
Conclusion	108
Bibliography	114
Preface	

Experimental studies of uranium-water gratings have been a significant contribution to the development of WMWC reactors. Experiments to study the physical characteristics of the active zones of WMWC reactors were begun at the initiative of Academician I. V. Kurchatov and performed under his direction on critical test installations at the Institute of Atomic Energy imeni I. V. Kurchatov beginning in 1954. This study is continuing today on critical test installations and also on reactors that are in operation or being launched.

Various conceptions of the reactor experiment were used broadly and fully in investigating WMWC reactors. This provided the basis for developing research techniques, with due regard for the characteristics of uranium-water gratings, which greatly expand the potential of the reactor experiment. With the development and refinement of experimental technology, in particular electronic equipment, methods of studying WMWC reactors were refined and simplified and their accuracy became greater.

As a result, a vast program of experimental investigation of uranium-water gratings has been performed beginning with study of the fundamental possibility of obtaining a self-supporting fission reaction and ending with the development of powerful series-produced WMWC reactors,

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the most common reactors in nuclear power. Methods of calculating the active zones of WMWC reactors were worked out on the basis of experimental data obtained from critical test installations and operating reactors. Fuel reloading and reactor control have been refined and the reliability and safety of operating atomic power plants with WMWC reactors have been improved. Further research aims at study of the active zones of even more powerful and economical reactors of this type.

The primary emphasis today is being placed on experiments conducted on operating WMWC reactors. Various techniques have been developed for this which make it possible to conduct studies at atomic power plants. The primary purpose of these experiments is to study the physical characteristics of active zones under operating conditions.

The present work describes the experiments that precede launching WMWC reactors in operation. It attempts to show the outline and order of conducting experiments that have been developed during the research process and, in the opinion of the author, could be useful to other researchers. Some of the experiments on uranium-water gratings were conducted long ago, but the author considers it worthwhile to describe them because they are interesting to researchers and may be used in investigation of active zones. Descriptions of them may be found in articles and reports.

The book does not give a great deal of data on results of studies. If readers wish they may consult the appropriate primary sources, which are indicated by references. The point is that data obtained in experiments on freshly loaded active zones of WMWC reactors change as the reactor is used, but the character of the experimental investigation, method, and ideology remain the same.

The author does not claim to cover the subject in full because the process of improving research is a continuous one: new measurement techniques are being developed and new issues and problems arise.

In conclusion, the author considers it a pleasant duty to express gratitude to doctor of technical sciences S. A. Skvortsov, candidate of technical sciences G. L. Lunin, and candidate of technical sciences A. N. Novikov for examining the manuscript and making valuable comments.

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11,176
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PUBLICATIONS

CRYSTAL GROWING FROM SOLUTIONS AND MELTS

Moscow ROST KRISTALLOV IZ RASTVOROV-RASPLAVOV in Russian 1978 signed to press 26 Jun 78 pp 1-2, 266-267

[Annotation and table of contents from book by Valentina Aleksandrovna Timofeyeva, Nauka, 1900 copies, 267 pages]

[Text] This monograph is concerned with the elaboration of scientific foundations of the method of crystal growth from solutions and melts. Theoretical concepts of solubility and crystallization are considered. Quantitative physical chemical characteristics of multicomponential systems used to grow crystals are presented. Crystal growing is linked with the thermodynamic state of a solution and with change in kinetics of crystallization. Fundamental technological parameters of spontaneous and controlled crystallization are associated with the morphology and mechanics of crystal growth.

Intended for scientific workers and engineers involved in growing crystals from solutions and melts. Tables 70; illustrations 151, references 869.

Contents

Foreword	3
Introduction	7
1. Brief history	7
2. Distinctive methods of solution-melt crystallization	16
3. Evaluation of crystal growth and future development of the method	17
Chapter 1. General characteristics of solutions	18
1.1. Brief information on solutions	18
1.2. Solutions and melts	25
1.3. Role of the solvent	27
1.4. Most common solvent melts	28
Chapter 2. Physical chemical studies of solutions and melts	45
2.1. Range of study of physical properties of systems	45
2.2. Thermal properties of melts	46
2.3. Density	48
2.4. Electrical conductivity	51

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2.5. Viscosity	53
2.6. Meltability Graph	56
2.7. Cryoscopy of molten salts	58
2.8. Buoyancy of vapor above solution	59
2.9. Free energy of reactions of salt formation	65
Chapter 3. Solubility and Phase Formation	68
A. Solubility	
3.1. Study of solubility of high-temperature media	68
3.2. Methods of analysis of solubility	71
3.3. Graph of solubility of high-temperature compounds	74
B. Phase Formation	
3.4. Study of phase equilibrium in solutions and melts	97
3.5. Regions of stability in crystal phases	102
Chapter 4. Some Theoretical Information on Crystal Growth	116
4.1. Introduction	116
4.2. Formation of seed charges	119
4.3. Surface structure and mechanics of crystal growth	120
4.4. Elements of diffusion theory of crystal growth	123
4.5. Volumetric-diffusion and surface-diffusion models of crystal growth from solutions	127
Chapter 5. Use of methods of simulation of crystal growth	134
5.1. Introduction	134
5.2. Programming rate of system temperature drop	134
5.3. Calculating optimum rate of temperature drop from data on temperature dependency of solubility	139
5.4. Programmed cooling of solutions and melts, allowing for diffusion and supersaturation	142
Chapter 6. Fundamental physical chemical parameters of crystallization	148
6.1. General criteria of high-temperature solution crystallization	148
6.2. Metastable region	149
6.3. Supersaturation of solutions	151
6.4. Concentration of solutions	153
6.5. Rate of crystal growth	154
6.6. Kinetic coefficient of crystallization	161
Chapter 7. Crystal Growing	165
A. Spontaneous Crystallization	
7.1. Introduction	165
7.2. Analysis of fundamental technological parameters of spontaneous crystallization	166
7.3. Basic research	173
7.4. Growing large garnet crystals in spontaneous crystallization	176
7.5. Growing crystals of yttrium iron garnet with localization of crystal centers	181
B. Controlled Crystallization	
7.6. Introduction	183
7.7. Experimental technique	185
7.8. Use of modified Czochralski method	192

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7.9. Growing thin films	198
7.10. Growing volumetric garnets in oriented inoculations	207
C. Morphological Aspects of Crystals	211
Conclusion	224
References	226

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